Founded by Richard A. Proctor, 1881.

With which is incorporated Hardwicke's Science Gossip, and the Illustrated Scientific News.

A Monthly Record of Science.

CONDUCTED BY

Wilfred Mark Webb, F.L.S., and E. S. Grew, M.A.

"Let Knowledge grow from more to more."

—*Tennyson.*

Volume XXXIX.

New Series, Volume XIII.

1916.

London:

Knowledge Publishing Company, Limited,

Avenue Chambers, Bloomsbury Square, W.C.

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JANUARY, 1916.

SOME CYTOLOGICAL PROBLEMS RAISED BY RECENT CANCER RESEARCH.

By AUBREY H. DREW,

Pathologist, Royal Institute of Public Health.

THE jelly method of *in vitro* staining of cells, which was devised by H. C. Ross, has thrown so much light on certain obscure problems in cytology that an account of the method and its applications should be of service to biologists. The method consists essentially in an agar jelly film containing stain, or any chemicals whose effect it is desired to test, being poured on to a microscope slide and allowed to set. Living cells are then placed on the film, and the effect watched under the microscope. For blood and other animal cells a special jelly containing salts is necessary, as red cells haemolyse, and leucocytes die instantly on an ordinary salt-free agar film. Such a jelly is known as "Coëfficient jelly," and is prepared as follows: Weigh out accurately 0·8 gramme of sodium chloride and one gramme of sodium citrate, and dissolve them together in forty-nine cubic centimetres of molten two per cent. agar in distilled water. When dissolved and thoroughly mixed, add one cubic centimetre of an 8·3 per cent. solution of citric acid and mix again. This coëfficient jelly is then pipetted into test tubes, each tube having five cubic centimetres of the jelly placed in it. Suppose now it is required to stain the so-called nuclei of the polymorphonuclear leucocytes. The coëfficient of diffusion of these cells has been found by H. C. Ross to be 12. We therefore take a tube of coëfficient jelly, and add 0·3 cubic centimetre of a five per cent. solution of sodium bicarbonate and five cubic centimetres of Unna's polychrome methylene blue, and bring the total volume up to ten cubic centimetres by the addition of 4·2 cubic centimetres of distilled water. The tube is now steeped in a beaker of boiling water till the agar is melted and the reägents thoroughly mixed. It is then boiled in the naked Bunsen flame till it froths up, and two or three drops are poured on to a microscope slide and allowed to set.

Some blood is then taken from the finger and mixed with an equal volume of a three per cent. sodium citrate and one per cent. sodium chloride solution. This dilutes the blood and prevents it from clotting. A drop of this citrated blood is then placed on a cover-glass, and this is at once allowed to fall gently on to the jelly film. The slide is placed in the 37° C. incubator (blood-heat) for ten minutes, and is then removed and examined with the microscope, when it will be found that the blood-cells are beautifully spread out, and the nuclei of the polymorphonuclear leucocytes are just stained a distinct bluish colour. It will be

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noticed from the following equation that the jelly has been purposely arranged to stain the nuclei in ten minutes at 37° C.

$5S+3A+7h+t-(3C+N)=12$, where S=stain, A=alkali, H=heat, and t=time, c and n being the citrate and sodium chloride respectively contained in the coëfficient jelly. Now Ross has shown that alkalis and heat increase the rates of diffusion of stain and other substances into living cells, while acids and neutral salts delay it; and he has found that their effect on the rate of diffusion can be reduced to a mathematical basis; that is to say that it is possible to obtain a standard by means of which any one of these agents can be substituted for another to produce a similar effect. The amount of these different factors which have an equal effect has been conveniently called a unit. The unit of alkali is 0·1 cubic centimetre of a five per cent. solution of sodium bicarbonate, ten minutes being one unit of time, and 5° C. one unit of heat, 10° C. being regarded as unity. A temperature of 37° C. is reckoned as seven units. As neutral salts delay diffusion these must be deducted; and, if this be done, the above equation expresses in figures the effect of the jelly prepared as above. At first sight the equation looks as if one were adding or subtracting heat to alkali, and time from salts, and so on; but in reality, since these factors either accelerate or delay diffusion, we are only adding or subtracting units of one power, namely, diffusion into a cell. The equation is so arranged for simplicity. It must be borne in mind that the coëfficient of diffusion of a cell must be first determined before we can experiment accurately, as there would otherwise be considerable risk of killing the cell before you had obtained the desired effect of the chemical agent which was being tested. Now the coëfficient of diffusion of a cell has been defined by Ross as the sum total of the units of stain, alkali, and heat requisite to stain the nucleus in ten minutes, *i.e.*, in one unit of time, after deduction of the units of neutral salts present. Suppose we have some cells with which we wish to experiment, we must first ascertain their coëfficient of diffusion or *cf*. We therefore take a tube of coëfficient jelly, and add three or four units of alkali and two or three units of stain, 0·1 cubic centimetre of Unna's polychrome methylene blue being one unit of stain. The total volume is then made up to ten cubic centimetres with distilled water. The cells are then placed on a cover-glass, and applied to the jelly, and the preparation incubated at 37° C. If we find the nuclei unstained at the end of ten minutes, we then add another unit of stain or alkali, or both, and continue till we do find the nuclei to be just stained in the time. We then put down the numbers of units used, and deduct those of the neutral salts present, which is always constant, namely $(3c+n)$, and thus obtain the *cf* of the cell. For protozoa it is unnecessary to use coëfficient jelly, a simple two per cent. agar jelly, with stain and alkali added, being sufficient, and the rapidity of the diffusion of the stain can be controlled by varying the amount of alkali present. The peculiar advantages of this jelly method applied to protozoa are that the diffusion of the stain can be watched while the cells are actually alive, and nuclear changes can be observed with the parts differentially stained. Active motion is restrained, and flagellates can be better examined by this method than by any other. Having briefly described the method, let us consider what new facts have been revealed, and what modifications of older theories have been rendered necessary by these facts. In 1909 H. C. Ross induced divisions in human lymphocytes, polymorphonuclear leucocytes, and certain epithelial cells. These results were confirmed by Sir Ronald Ross, and again independently by myself. The divisions were induced by means of the jelly method, with certain extracts of dead tissues (*e.g.*, suprarenal gland), and later some of the active principles of these extracts were isolated, such as creatin, tyrosin, xanthin, and so on. Ross and Cropper were subsequently able to show that division could be induced by these substances in the ova of *Ascaris megalocephala*, while E. H. Ross proved their action on certain trypanosomes. Fantham showed that the division of *Entamoeba coli* could be accelerated by means of tyrosin, whilst I was able to demonstrate that the full development could be induced in the winter resting spores of *Polytoma granulosa* by means of several of these excitors of cell-reproduction. More recently Cropper and myself have demonstrated that amoebae will not divide at all unless auxetics are present. These results have been confirmed by experiments on animals, namely, by the production of benign tumours, adenomata, in the ducts of goats' breasts, and of a condition resembling epithelioma in the skin of mice, guinea-pigs, and rabbits by the injection of various combinations of auxetics and kinetics. Ross employed the term "auxetic" for these substances, and they appear to belong to certain definite chemical groups, notably, the primary amines, amino acids, and amidines, all of which contain the NH radicle. In addition to these substances certain other chemical compounds, notably, the alkaloids, had been found capable of causing greatly exaggerated amoeboid movements in leucocytes, and these were termed "kinetics." Some of these were observed to quicken the action of auxetics in the cells, and were therefore called "augmentors." This, then, was the position of affairs at the end of 1912, and the result of these experiments forces one to the conclusion that living matter does not possess any inherent capacity to reproduce itself, but has to absorb or to be acted on by an auxetic before this will take place. The subject was then taken up by Cropper and myself with a view to determine, if possible, the way in which auxetics are capable of exciting cell-division; and, after an extremely laborious research, we were able to show conclusively that, if amoebae are entirely

freed from living bacteria, they may be fed on dead bacteria, which they will ingest; but there is not the slightest attempt at reproduction until an auxetic is supplied to them. Also, in addition to this, we found that before an auxetic can act it is necessary to add some enzyme, the exact nature of which has not yet been determined. It thus appears as if the auxetic may act as a sort of amboceptor in locking the ferment on to the chromatin of the cell, and in this way enabling the ferment to originate the process which ultimately causes the cell to divide. Some criticism has been made from time to time on Ross's induced figures in lymphocytes, but a great deal of it is due to the fact that the critics have only judged from *prima-facie* evidence, and have not taken the trouble thoroughly to investigate the matter for themselves. It has been suggested, for example, that the figures are due to cell death-struggles. Reflection shows at once the fallacy of such a statement, apart from the fact that actual divisions have been watched, and that it is possible by precise enumerative methods to demonstrate an increase in a leucocyte population; the objection will not stand on any biological grounds. In the induced division figures the chromatin is distributed with more or less regularity between the two daughter cells. The protoplasm of the cell becomes constricted into two approximately equal parts. In the process of death, on the other hand, the cell tends to become rounded up, and the chromatin shows no obvious karyokinetic changes until degeneration sets in. Since auxetics have been conclusively shown by an overwhelming amount of experimental evidence to cause multiplication of cells, such as ova, polytoma, amoebae, and so on, in which the appearances induced by auxetics conform with the generally accepted views regarding cell-division, it is impossible to avoid the conclusion that, when lymphocytes are placed under similar conditions, and exhibit the phenomenon of division, they are actually dividing, and not merely undergoing distortion by death-struggles. It has also been urged that Ross has wrongly claimed the induced figures to be mitotic, but in the protozoa one sees a great diversity of types of nuclear division from absolutely amitotic to division by mitosis of a very perfect kind, and in all cases where definite chromosomes are formed, the division is spoken of as mitotic. In the process of division of human lymphocytes induced by auxetics the centrosome first divides, and the two daughter centrosomes take up their position at opposite ends of the so-called nucleus; definite chromosomes are then formed, and these are accurately shared between the daughter cells. Moreover, with appropriate treatment, thirty-two chromosomes can be counted, which is the somatic number in the human species. It is therefore beside the question to say that the term "mitotic" should not be applied to the dividing lymphocytes. The whole controversy really depends on the new details of structure of lymphocytes revealed by the new jelly method contrasted with the comparatively little structure shown by the old fixed films. When a drop of fresh blood is examined by the jelly method the cells are beautifully spread out, and are obviously alive; and it is at once seen that a lymphocyte contains a large rounded, clear space bounded by a wall, which selects the blue portion of stain in polychrome methylene blue (the so-called nucleus). Within this is a small ring-shaped body, which is shown by its functions during cell-division to be a centrosome (see Figure 1). The so-called nucleus is seen to be studded all over with minute granules, which are in the cytoplasm, and which during division form the chromosomes, the nucleus forming the spindle (see Figures 2, 3, and 4). By any of the older methods of fixing or staining it is quite impossible to recognise this structure. The existence of the ring-shaped centrosome, for instance, was not demonstrated until the jelly method was employed. There would possibly have been little criticism of the mitotic figures had the new methods not revealed the revolutionary fact that the chromosomes are formed from the Altman's granules outside the nucleus. By the older methods of fixing and staining the nucleus of a lymphocyte merely appears as a deeply stained, circular body surrounded by a layer of clear cytoplasm; and, although they had never been seen to divide, it was argued that the chromosomes must of necessity be formed within the nucleus, as occurs in most other cells. There can be little doubt that the jelly method of *in vitro* staining will gradually supersede the older methods, as by its use cells can be examined, not dead, but in the living condition, with their parts differentially stained--a condition which was never possible until the jelly method was devised. By means of this, most important results have been attained in cancer research; thus it has been shown that auxetics and kinetics can, when suitably inoculated into animals, give rise to very definite tumours, some of them closely resembling those met with in cancer. Again, it has been known for years that workers in the tar and pitch industry were very liable to suffer from cancerous affections, the old chimney-sweep's cancer being a fairly typical example of such cases. There are two forms of pitch, namely, gasworks pitch and pitch largely manufactured from the harder Scotch coal, and known as blast-furnace pitch. Now the peculiar and important point in this connection is that only the gasworks pitch and tar predispose to cancer, the blast furnace product being harmless. Careful examination of these pitches has brought to light the fact that gasworks tar and pitch contain both auxetics and kinetics (augmentors), while blast-furnace pitch contains only a trace of auxetics and no kinetics. The importance of such a discovery to the cancer problem can easily be seen. It has also recently been found that the presence of auxetics and kinetics plays a very important *rôle*

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in the awakening of life in spring-time, and many important results have been attained amongst those protozoal parasites which are the cause of syphilis and other diseases in the human subject.

Nearly all this work with the jelly method has been done under the auspices of the Research Fund, generously provided by Mr. John Howard McFadden. Much work remains to be done before the whole method is fully elucidated, and it is to be hoped that many workers will try it.

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CORRESPONDENCE.

GIANT AND DWARF STARS.

To the Editors of "KNOWLEDGE."

SIRS,—In the November number of "KNOWLEDGE" Dr. Crommelin gives an appreciative account of Professor Russell's theory of stellar evolution. He also discusses its difficulties, as pointed out at the British Association Meeting, and fully reported in *The Observatory* for October. In the same number of "KNOWLEDGE," in the "Graphics of Gravitation," it is shown that the factor of quantitative chemical composition must play a large part in stellar evolution and in the character of spectrograms. At the B.A. meeting Sir Ernest Rutherford pointed out that some nebulae are probably the result of expansion, due to impact. When these two factors of chemical composition and expansion are taken into account, as well as age, the difficulties seem all to disappear.

If we look upon the Galaxy as having originated by the interpenetration of a sidereal system and a gaseous primordial system, as deduced from observation by Kapteyn and as suggested by induction in 1880, then it is reasonable to assume that stars, accordingly as they originated amongst green gaseous nebulae or white meteoric nebulae, will be of different chemical composition. Professor Fowler suggested that Sir Ernest Rutherford's idea of expanding nebulae must be rare and abnormal. Doubtless this would be true were impact of suns a mere random occurrence. But it has been shown that a dozen agencies are tending to produce such impacts.

Let us examine stellar evolution in the light of these two additional factors. Let us, as suggested in 1878 to 1880, assume that planetary nebulae have expanded from colliding stars. This idea of their origin gives reasons for their tendency to concentric formation, to bilateral symmetry, and to high velocity. Then, when we think of stars differing in the ratio of free hydrogen from a mere trace to a volume of thousands to one, many of the different characters of spectrograms are explained. In considering age, on the basis of the dynamical theory of gases, we see we have to divide the effect of contraction into two sharply divided stages: the stage when the molecules are far enough apart for the gaseous laws to act, and the stage when there is no room for free motions—when the molecules are permanently in contact, and the subsequent locking of the molecules into solids.

A truly gaseous sun doubles its temperature each time it halves its diameter. That is, the more heat it radiates the hotter it gets. This paradoxical result is due to the fact that as the molecules fall towards the centre they increase their velocity; a part of this kinetic energy is radiated and a part retained; so the star gets hotter. When a sun contracts to half diameter we see a disc of one quarter the area and of double the temperature.

Now, when a sun of a given mass contracts, the graphics of gravitation show us the kinetol of its photosphere is inversely as the radius. The increased velocity represented by this greater kinetol increases the width of the hydrogen absorption bands. At the same time helium, having only one-fourth the kinetol of hydrogen, tends to fall out of the chromosphere into the photosphere. Thus there is a tendency for ordinary helium stars to become Sirian stars. Bright-line helium and Wolf-Rayet stars have probably too much hydrogen ever to become Sirian stars, and Sirian stars can never become solar stars. But Giant Antarian stars may become solar, and sometimes Procyon stars, as the temperature of the photosphere increases.

All stars may become dwarf M stars, as that is a condition of decay and death.

When the molecules have no room for free excursion, as the temperature gets low enough they coalesce to liquid, and then cohere to solid. But the total energy radiated at this stage would not be one thousand that lost by the gaseous diminution to the last one-half radius. However, this process of death is lengthened out by the conversion of potential energy into kinetic, by chemical combination, and by the latent heat of liquefaction and solidification that will generally be converted into kinetic energy in the gravit nucleus as it becomes solid. Convection will also cause its last red stage to last long. Hence the reason for the immense number of dwarf M stars. We must remember that dead, very levit stars, except the gravit nucleus, will all be permanently gaseous stars. Yet, when these have been a long time dead, they may be approximately at the temperature of space. Yet if the gravit nucleus be a small ratio, these dead suns may be very rare stars.

It is thus seen, that by adding the factor of expansion suggested by Sir Ernest Rutherford, and the factor of varied chemical composition suggested by Kapteyn's idea of the constitution of our Galaxy, we have a consistent system of stellar evolution. We see planetary nebulae condensing to Wolf-Rayet stars; the same kind of stars forming in green nebulae—bright-line helium stars having a greater ratio of gravit centre than these, yet forming in the same way. So the order is P,O,B,A,F,G,K,M. N, or carbon stars, are probably a special class, possibly so rich in oxygen that no free hydrogen remains to form a chromosphere. Call dwarf M, Mx, and the Harvard and Secchi order remains, as suggested by Professor Fowler and Father Cortie, and Professor Russell's suggestion is seen to blend with the Harvard notation.

A. W. BICKERTON.

18, PEMBRIDGE MANSIONS,
MOSCOW ROAD, W.

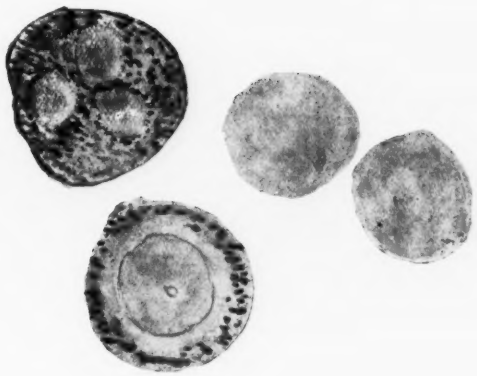

FIGURE 1.
Division figure in a lymphocyte, polar aspect.

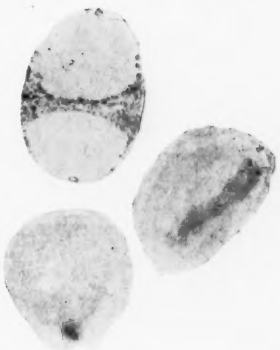

FIGURE 3.
Division figure in a lymphocyte, profile.

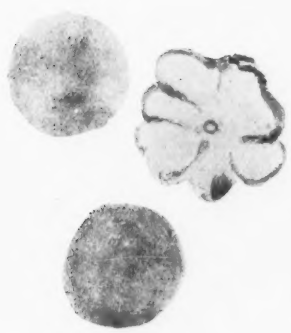

FIGURE 2.
Lymphocyte and polymorphonuclear leucocyte.

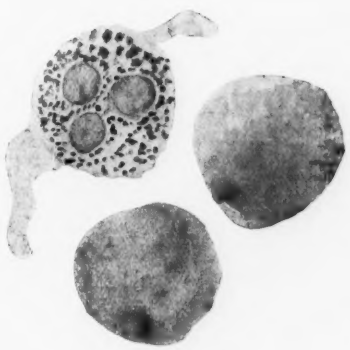

FIGURE 4.
Amoeboid movement in leucocyte induced by choline.

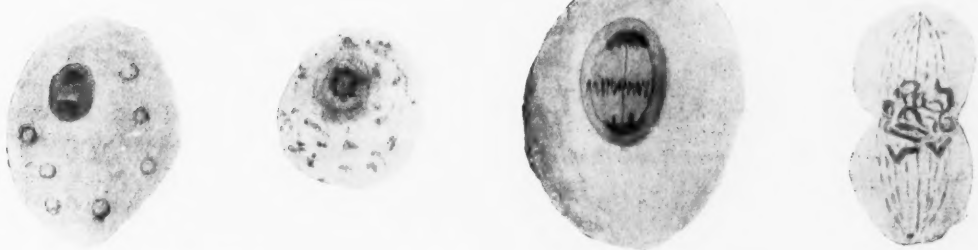

FIGURE 5. FIGURE 6. FIGURE 7.
Various nuclear changes in protozoa examined on auxetic jelly. Amoebae.

EXAMPLES OF THE "JELLY METHOD."

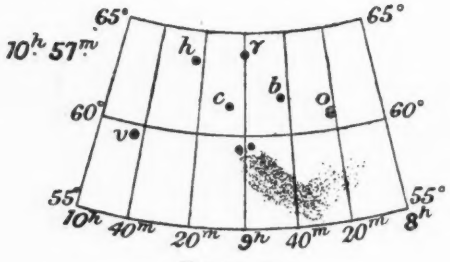

FIGURE 8.

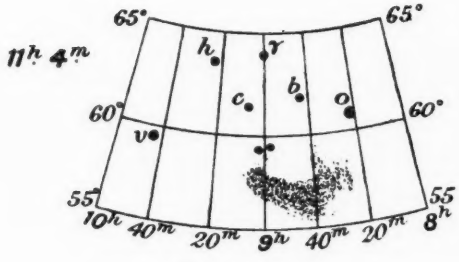

FIGURE 9.

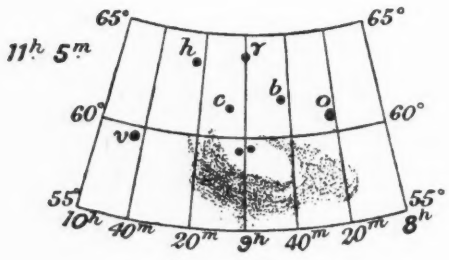

FIGURE 10.

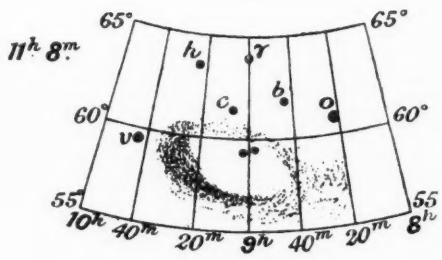

FIGURE 11.

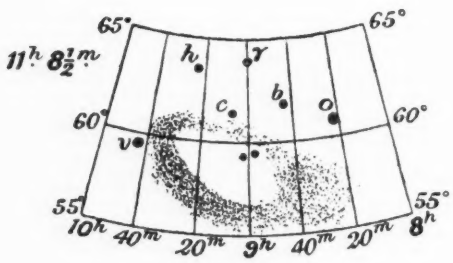

FIGURE 12.

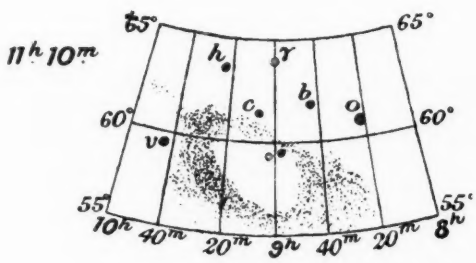

FIGURE 13.

STREAK OF FIREBALL, OCTOBER 5TH, 1915.

(By the courtesy of the British Astronomical Association.)

A REMARKABLE FIREBALL.

By FIAMMETTA WILSON.

OCTOBER 5TH was a most remarkable night for meteoric activity. The sky was perfectly clear, and I could see 6·2-magnitude stars quite plainly. In a watch of 4h. 30m., I recorded twenty-nine fireballs and meteors, and saw others which I could not record during the time I was watching an enduring streak, left by a very large fireball for 17m. 56s.

This fireball appeared at 10h. 56m. from 140°+68°, and was then greater than magnitude 1. At 130°+61° it burst out to magnitude=½ ☽, and disappeared at 126°+57°. It lighted up all the surroundings, and the colour was reddish yellow. The streak that remained was at first a very broad, thick one, and very dense on the eastern side. Nebulous matter seemed to be moving with great velocity, like a sort of whirlwind. The western side then extended itself both east and west, undulating slightly north and south. Both sides joined up then into a circle moving east and a little north. The eastern side still appeared the brighter, but the whole appearance was more nebulous..

The sky could be plainly seen in the middle of the circle. With binoculars I saw the stars 3086 B.A.C. and LL 1433 under the northern edge. The circle became larger and more hazy, although perfectly distinct, and still the eastern movement went on till 11h. 10m. During the last five minutes there appeared no movement of the whole circle, but only of traces of nebulosity. The spaces between 141°+63°·5 and 146°+59°·5 on the eastern side, and 126°+61° and 130°+58° on the western side, looked as if portions of the Milky Way had settled there. The last I saw of it was at 145°+61°, after the whole circle had disappeared.

Mr. Denning wrote to some of the daily papers, and received accounts from several people who had seen this fireball. From these he estimated the heights to be eighty-two to fifty-five miles, with a velocity of thirty-five miles a second. The flight was from over Lampeter to Neath, South Wales. The eastern part of the streak drifted towards north-west by north with a velocity of ninety-five miles per hour.

*ASTROPHIURA CAVELLAE** (Koehler, n. sp.)

Professor René Koehler explains that *Astrophiura* was founded on a solitary specimen, presumably from Madagascar, and that it was named on the supposition that it showed very primitive characters, making it a link between the groups that gather round *Asterias* and *Ophiura*. Recently Japanese waters have yielded a second species of the genus, also described from a single specimen. A third species here in question, from the Agulhas Bank, has led Dr. Koehler to contravene the opinion that this genus is inferior or archaic. Rather he thinks that it belongs to the true Ophiuras, and even that it represents a much developed *Ophiura* with special characters, due to transformations brought about in structures already strongly differentiated. He has had at command five specimens. Unfortunately all died, and in respect of the delicate arms all were mutilated. They were obtained by the Valdivia Expedition, under the scientific leadership of the late Dr. Carl Chun, a German of charmingly amiable character. *O si sic omnes!* Dr. Koehler noticed that Chun, in his interesting work, "Aus den Tiefen des Weltmeeres" (page 488), gave a drawing of the species without being able to refer it to *Astrophiura*. It should, however, be remarked that in the second edition, 1903, at page 171, the figure is named *Astrophiura* sp., and a brief discussion in the text refers it to the Ophiuridae. Dr. Koehler considers that the genus should be the type of a family, Astrophiuridae, or perhaps eventually of an order. In the meantime, the new species is named in honour of a martyred Englishwoman, to whom may well be transferred the classic eulogium—

"Non ille pro caris amicis
Et patria timidus perire."
("Country to help and friends to shield,
She trembled not her life to yield.")

T. R. R. S.

NOTES.

ASTRONOMY.

By A. C. D. CROMMELIN, B.A., D.Sc., F.R.A.S.

THE AMERICAN ASTRONOMICAL SOCIETY met in California last August. *Popular Astronomy* for November contains an interesting summary of the papers. Mr. W. S. Adams gives an investigation of the radial velocity of stars that have very small proper motions, and are presumably very distant. After correcting for the solar motion, the mean results range from eight and a quarter kilometres per second for Class B to twelve and a half kilometres for Class M. If these are corrected for stream motion, in a manner suggested by Professor Eddington, the range becomes still less. The conclusion is that the distant stars move more slowly than those near us, and also the variation of speed for different spectral type is less. This may be explained in two ways. Either the speeds are really less in parts of the stellar system remote from the centre, or it simply means that these stars are larger than the average (otherwise they would not be visible at such great distances). Now it is quite probable that the stars with greater mass move more slowly than those with small mass. This would be in good accord with the fact that the faint stars in the immediate vicinity of the Sun, whose mass is probably small, have unusually high velocities.

A good deal of work has been done on the interesting star BD+30°·3639, which Professor Campbell found to be surrounded by a hydrogen envelope. Mr. Wright photographed

* *Bulletin de l'Institut Océanographique*, Monaco, No. 34, November 30th, 1915.

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its spectrum at the Lick Observatory, finding all the brighter nebular lines except those at 3869 and 4363, in addition to the hydrogen and helium lines. In other words, it is a planetary nebula, and the central star proves to be a Wolf-Rayet star. It is probable that the close connection established between these two classes of objects is not an accidental, but a general one.

About two years ago I mentioned the very high velocity in the line of sight found by Mr. Slipher for the Great Andromeda Nebula. He now gives results for eleven nebulae; all are receding from us except the first three, which are approaching. The speeds are given in kilometres per second; the numbers of the nebulae are those in Dreyer's New General Catalogue: No. 221, 300 kilometres; No. 224, 300 kilometres; No. 1023, 200 kilometres; No. 1068, 1100 kilometres; No. 3115, 400 kilometres; No. 3627, 500 kilometres; No. 4565, 1000 kilometres; No. 4594, 1100 kilometres; No. 4736, 200 kilometres; No. 5866, 600 kilometres; No. 7331, 300 kilometres. It will be seen that the speeds are very high, and some astronomers are disposed to question whether the shifts in the spectral lines may not arise in some other way than by motion in the line of light. Assuming that they indicate motion, these speeds support the inference that the spiral nebulae are external universes. It is quite a reasonable supposition that the speed of one universe relatively to another should be higher than the internal speeds in each.

If we provisionally assume that the high speeds are correct, it is clear that we can get an idea of the distance of these nebulae by measuring their apparent proper motion, since on the average the cross speed should be equal to that in the line of sight. The late Professor Keeler photographed many nebulae at the Lick Observatory fifteen years ago. Mr. Curtis has lately repeated the photographs. The time-interval is, of course, not long enough to give accurate determinations of the motion of ill-defined objects. However, he has deduced 0″·03 as the average annual proper motion of all classes of nebulae. He deduces that the annular and planetary nebulae are about a thousand light-years distant, and therefore within our stellar system. The spiral nebulae appear to be at least ten times as remote.

Professor Campbell and Mr. Moore have made an examination of the speed in the line of sight of nebulae with bright-line spectra. They find ten kilometres per second for extended nebulae, twenty-eight kilometres for annular and disc ones, fifty kilometres for stellar ones. It is concluded that these nebulae belong to our stellar system, a conclusion which is strengthened by the fact that they give the same solar motion (twenty kilometres per second) that the stars do. There are, however, two remarkable groups of bright-line nebulae that give enormous speeds. Twelve nebulae in the greater Magellanic Cloud have recessional speeds that average two hundred and seventy-seven kilometres per second; while the single one observed in the smaller cloud has a speed in the same direction of one hundred and sixty kilometres. It is reasonable to conclude that these nebulae are really connected with the clouds by their sharing this wonderful speed (unique for nebulae with bright-line spectra), and from the fact that no other bright-line nebulae are seen in the same region. This is strong confirmation of the Magellanic Clouds being external systems. Hertzsprung had already reached the same conclusion on other grounds, estimating their distance as thirty thousand light-years. If this distance is near the truth, it would appear that the distance between universes is of the same order as the diameter of our own universe, which is almost certainly several thousands of light-years. The stars that are visible in the Magellanic Clouds must be of brilliancy comparable with the brightest helium stars of our own universe. Professor Campbell is attempting to observe the spectra of some of them; and if they show the same great speed as the nebulae it will further confirm the motion of the Clouds, and make it possible to determine which stars belong to them and which to our own system.

MARS.—Professor W. H. Pickering makes a proposal for a Martian calendar to facilitate the correlation beteeen the position of the planet in its orbit and changes on its surface. The Martian year contains 668·6 Martian solar days. To avoid fractions he takes it as 669, which he divides into twelve months, the first nine having fifty-six days each, the other three fifty-five. Thus eight weeks go to a month. The months are given the terrestrial names, beginning with March. March 1st is the day of the vernal equinox of the planet's northern hemisphere. The summer solstice falls on June 27th; the autumn equinox on September 36th; the winter solstice on December 12th. Aphelion falls on May 31st; perihelion on November 31st. The use of the calendar is recommended as being likely to lead observers to follow the Martian seasonal changes. For example, Professor Pickering suggests that some regions are green at both equinoxes, the colour being strongest at the autumn equinox. Others (Acidalium, Sabaeus, and Syrtis Major) are blue soon after the polar caps begin to melt, which is ascribed to their being covered with water from the melting snow. There is stated to be more cloud after the melting of the southern cap than after that of the northern. The Martian clouds appear yellow to him, and he notes that Venus seen by day also looks yellow. He has already commenced observations of the present apparition of Mars at his observatory at Mandeville, Jamaica. He noted a striking change in the colour of the desert areas between July 18th and September 8th. Their colour was at first represented by a mixture of yellow ochre and raw sienna; afterwards by golden yellow. He explains this by supposing that there was more thin cloud or mist in the Martian air on the second date. Some careful studies were made of the colours on the disc. That of the desert regions is given as brick-red, and ascribed to oxide of iron. Experiments on the visibility of a hair with the naked eye showed that it could be seen at more than sixty feet distant, subtending an angle of less than 1″. This agrees well with Professor Lowell's result. Thus at a perihelion opposition canals would be visible if two or three miles in width. Two pinholes a millimetre apart could be separated eight feet away, the angle being 86″.

CHEMISTRY.

By C. AINSWORTH MITCHELL, B.A. (OXON), F.I.C.

THE TOXIC PRINCIPLE IN COTTON SEED.—Cotton-seed meal, after expression of the oil, is now used extensively as a feeding-stuff for cattle in the United States. But if the animal has not been gradually accustomed to the food, poisoning and death may occur, and for this reason it is now generally avoided as a food for pigs. This toxic action has been attributed to various constituents of the seed, including the oil, the high protein content, and a salt of phosphoric acid; while decomposition products and a supposed toxic alkaloid have also been held responsible for the trouble.

In 1899 Marchlewski separated the colouring matter of cotton seed, which he termed "gossypol," and proposed to use as a dyestuff. It has now been found by Messrs. Withers and Carruth (*Journ. Agric. Research*, Department Agriculture, U.S.A., 1915, V, 263) that this phenolic constituent, gossypol ($C_{13}H_{14}O_4$), is the principal, if not the only, cause of the toxic action of cotton seed and cotton-seed meal. It can be extracted from the seed by means of ether after separation of the oil by means of petroleum spirit, and may be purified by precipitation from an ethereal solution or by crystallisation as an acetate. The yield of crystalline acetate obtainable from the seeds is about 0·8 to 1·0 per cent. Both in the crude and the purified form, gossypol is poisonous to animals, whether given in a single large dose or in small daily doses. It was fatal to rabbits when given in the proportion of 0·25 gramme per kilogramme of body weight.

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When treated with oxidising agents it is oxidised to an organic acid, which is not toxic; and to this must be attributed the destruction of the toxicity when cotton-seed meal is boiled with alcoholic caustic soda. The seed kernels are rendered less toxic by partial extraction with ether or alcohol and ether; while complete extraction of the gossypol leaves an innocuous residue. Treatment of the meal with iron salts also reduces the toxic action, possibly by oxidation of the gossypol or by combining with it to form an insoluble coloured lake.

The chief difficulty in the way of treating the meal in bulk is that the seed tissue surrounding the cells containing the gossypol interferes with the efficient action of solvents or of chemical agents.

MANUFACTURE OF SYNTHETIC PHENOL.—During the South African War the shortage of phenol in Europe caused Raschig to start the production of artificial phenol on a manufacturing scale at Ludwigshafen, and its manufacture has been continued ever since whenever the price of benzol has been low enough to make it profitable. The same synthetic process has now been utilised by Edison in America to obtain the phenol required for the resinous condensation products used for the discs of phonographic machines.

In the *Met. and Chem. Engineer* (1915, XIII, 686) Mr. E. H. Ney gives an outline of the method in use. The benzol is mixed with strong sulphuric acid in a cast-iron vessel beneath a reflux condenser, and the mixture heated for about seven hours. The sulphonated product is neutralised with milk of lime and calcium carbonate, pumped through a filter press, and the residue washed with water. The filtrate is treated with sodium carbonate to convert the calcium benzene sulphonate into the sodium salt, the liquid evaporated, and the residue of sodium benzene sulphonate dried, powdered, and heated with a solution of caustic soda. The resulting product is dissolved in water, and the liquid treated with sulphuric acid until sulphur dioxide is evolved. This is expelled in a current of air, and the residual crude phenol is separated and purified by digestion or distillation with animal charcoal.

SOLUBILITY OF PALLADIUM IN SELENIC ACID.—The behaviour of palladium towards selenic acid has been investigated by H. Hradecky (abst. *Journ. Chem. Soc.*, 1915, CVIII, 472). Like gold and silver, palladium will dissolve completely in the acid at the ordinary temperature, provided it be in a fine state of division. The resulting solution is of a deep reddish brown colour, and when concentrated gives a mixture of palladous selenate and selenous acid.

Pure palladous selenate ($PdSeO_4$) may be obtained by dissolving palladium in a mixture of nitric and selenic acids. It crystallises in small dark brownish red rhombic prisms, which absorb water readily from the air. It combines with ammonium sulphate and ammonium selenate to form double salts. These are prepared by dissolving the two salts in concentrated hydrochloric acid and causing the solution to crystallise. When heated with hydrochloric acid, palladous selenate decomposes the acid, with the liberation of chlorine.

Selenic acid also dissolves alloys of gold and silver, and of gold, silver, and palladium; and it is suggested that the acid may prove of service in the analysis of such alloys. For example, by treating an alloy of silver and platinum with selenic acid, decomposition takes place with solution of the silver; while the platinum is left as an insoluble residue.

GEOGRAPHY.

By ALEXANDER SCOTT, M.A., B.Sc.

OVERFLOW CHANNELS.—In a recently published pamphlet Professor Bonney criticises at some length Kendall's explanation of the so-called "overflow channels" of the North of England. After pointing out the general difficulties which stand in the way of the "land-ice theory," this author gives the results of a detailed examination of several of the best-known examples. The "railway-cutting" trenches are considered by some to have attained maturity; by others to be young valleys. If the former view is correct, then they must be, as Bonney maintains, the relics of very ancient river-systems which have been cut into by more recent transverse streams. The trenches have not the typical V-shaped cross-section of glacier-rivers, but this may be due to the comparatively slight gradient, since a valley will tend to become U-shaped if the gradient is low. The absence of deltas is also a serious objection to the "overflow theory," in view of the enormous amounts of débris which modern glacier-rivers, such as those of Iceland, carry with them. To the present writer some of the trenches seem to be a compromise between U- and V-shaped valleys, such as might arise from the action of a slow stream with a heavy load. It is possible, however, that some of the channels may be due to the reëxcavation of older filled-up valleys.

With regard to the "in-and-out channels," the glacial theory is more unsatisfactory. It is difficult to conceive a stream flowing between a hillside and a glacier without cutting the latter to a much greater extent than the former. The differential erosion of the two banks would be such that the stream would tend to become subglacial, and work down to lower levels. The result would be a hillside, shelving gradually outwards, instead of a flat ridge. Although the alternative explanation—that the channels arise through differential earth-movements steepening one slope—is not entirely satisfactory, it seems more feasible than the glacial theory.

The whole question is very complicated, and a large amount of conflicting evidence is accumulating on each side. Thus the existence of a typical "railway-cutting" trench in Norfolk, and of a large cross-cut near Cader Idris, is certainly in favour of the view that such channels may arise without the assistance of glacier-lakes. On the other hand, several channels have been found in various parts of Britain, which are very difficult to correlate with any former drainage system, and which, so far as present knowledge goes, must be assumed to be due to lake overflows.

THE GREENLAND ICE-CAP.—While the journeys of Peary, Nansen, and others resulted in a considerable access of knowledge concerning this ice-cap, there is still great room for further investigation, and Wegener's account of his observations, made during his journey across Greenland in 1912–13, are therefore welcome (*Zeit. für Erdkunde*). On the eastern and western margins of the ice-sheet, stormy conditions prevail, but in the centre there is a calm atmosphere, intensely supersaturated with moisture, and rendering exploration very disagreeable. The average surface temperature varies from —15° C. at the margins to —32° C. in the interior, and borings in the snow showed a gradient of 1° C. per sixty-five feet. The snow is distinctly stratified, a fine-grained top layer overlying a coarse-grained one, the stratification being apparently due to seasonal variations in the precipitation. At the winter station, which was situated on the inland ice, a large number of physical observations was made. Those on the crystal habit of snow, and the peculiar optical effects during the long twilight, may be specially mentioned.

GEOLOGY.

By G. W. TYRRELL, A.R.C.Sc., F.G.S.

PRESENT CONDITION OF THE VOLCANOES OF SOUTHERN ITALY.—Messrs. Washington and Day visited Vesuvius, Etna, Vulcano, and Stromboli, in the summer of 1914, in order to determine the nature and interreäctions of the magmatic gases, and to confirm the presence of water amongst them, as at Kilauea ("KNOWLEDGE,"

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April, 1914). They have prepared some interesting notes on the phenomena they witnessed in these volcanoes (*Bulletin Geological Society America*, September, 1915). Since the great eruption of 1906 Vesuvius has been in a condition of repose, the longest repose-interval since the beginning of the eighteenth century. There is, however, considerable fumarolic activity. The hot, acid gases emitted from the fumaroles have disintegrated the rocks in their vicinity, and are contributing materially to the demolition of the cone. The floor of the crater is slightly domed, covered with ash from which perfect augite crystals may be gathered, and strewn with angular blocks fallen from the sides. Hot vapours, mainly hydrochloric acid gas, sulphur dioxide, and steam, fill the crater with a blue mist. The summit crater of Etna is now in the middle of an ash cone, rising a thousand feet above a plateau, both of which are thickly covered with fine, dark-grey ash, with many small cones. Concentric fissures indicate that the crater is in process of enlargement. Etna is now showing both fumarolic and Strombolian phases at intervals, without marked activity.

Vulcano has been in an almost continual state of fumarolic activity since its last eruption in 1888–9. The circular crater is much shallower than formerly, and has two well-defined terraces which run almost completely around the circle. The fumarolic activity is intense, and has given rise to a great deposition of salts, mainly sulphates of alumina and potash, which are ankle-deep in places.

Stromboli is regarded as the type of continuously active but gently eruptive volcanoes, but recent investigation shows that it "presents long periods of varied, but for the most part moderate, activity, interrupted by relatively brief periods of repose." Five active vents were seen by Washington and Day. One of these explodes at short irregular intervals like the discharge of a large-calibre gun, and red-hot fragments of half-molten rock are ejected to a height of several hundred metres, accompanied by a tall column of brown smoke. Another small vent "blows off" at intervals of twenty to forty minutes with a loud, startlingly-sudden blast, like the letting-off of steam from a gigantic boiler, with the rapid ascent of a tall narrow column of white smoke, while the edges of the orifice of eruption grow red-hot. At present there is not much fumarolic activity on Stromboli.

OÖLITIC IRON ORES OF NEWFOUNDLAND.—These important deposits, which furnish nearly fifty per cent. of the iron ore smelted in Canada, are described by A. O. Hayes in *Memoir* No. 78 of the Canadian Geological Survey. The ore is found in a series of sedimentary rocks of Lower Ordovician age, which has closer affinities with European than with American geological formations, and is consequently referred to the Arenig and Llandeilo of Wales. There are three principal ore beds in a thickness of about 400 feet of strata, consisting of ferruginous shales and sandstones. They are characterised by ripple-marked surfaces and cross-bedded layers, and contain remains of marine animals which lived in shallow water.

The ore is oölitic, and the spherules consist of concentric layers of haematite and chamoisite (a green aluminous ferrous silicate). They were pierced, as shown in thin section, by living boring algae, and it is therefore concluded that the iron minerals were precipitated near the surface of deposition whilst the algae flourished on the sea floor. The algae are found in all horizons in the ore beds, and evidently formed an abundant marine plant life.

It is believed that the ore occurs as a primary bedded deposit, and that the oölitic grains were formed at the time the ferruginous sediments were laid down. They are occasionally found in layers alternating with earthy haematite, which have been clearly arranged by the sorting action of water. For many oölitic iron ores the theory has been put forward that they are derived by replacement from an original oölitic limestone; but there is a complete absence of limestone from the Wabana section, and there is no evidence for such a change.

PILLOW LAVAS IN MULL.—In continuation of the record of pillow lavas in this column, we may note an interesting occurrence in the island of Mull, which is described in the current *Summary of Progress* of the Geological Survey of Great Britain. The igneous history of Mull is most complex, and many novel volcanic features are now being worked out by the officers of the Geological Survey. The pillow lavas occur within a restricted area, and the structure in one place recurs at intervals through a pile of basalt lavas estimated at three thousand feet thick. The well-marked chilling of the surfaces of individual pillows leads to the conclusion that the lavas were formed in water. The inner limit of the pillow lava zone is determined largely by the occurrence of igneous rocks probably of later date. At the outer limit is a zone of ancient gneisses, with Mesozoic sediments and associated Tertiary intrusions; and still further lie the extensive lava fields of Mull and Morvern. As yet pillow structure is unknown amongst the lavas of this outer region. It is believed therefore that the lake in which the pillow lavas were accumulated was restricted to the centre of Mull; and, as it reäppeared at intervals during the development of thousands of feet of lava, its position was probably determined by a volcanic caldera due to subsidence, like those of Hawaii. The small part that sediments play in the infilling of the hollow suggests that the surrounding volcanic surface sloped away from the lip of the caldera. The high inward dip of the pillow lavas, amounting in one place to verticality, is another indication of origin within a caldera.

METEOROLOGY.

By WILLIAM MARRIOTT, F.R.MET.SOC.

WEATHER AND POTATOES.—Professor J. Warren Smith has carried out an elaborate investigation on the effect of weather upon the yield of potatoes in the United States, and has contributed a paper on the subject in *The Monthly Weather Review*. The potato has made its greatest development in the cooler sections of the country, where the mean annual temperature is between 40° and 50°, and where the mean temperature for July is not over 70°. The greatest yields of potatoes are in those States where the mean annual temperature is below 45°, and where the mean of the warmest month is not far from 65°. The greatest number of days (over one hundred) between the beginning of planting and digging is across the central part of the country and in Northern Maine; while the least number of days is seventy-six in North-eastern Ohio.

Professor Smith has worked out the correlations for the combined effect of temperature and rain upon the yield of potatoes in Ohio for the fifty-five years, 1860–1914, and finds that warm and wet weather in July produces a bad effect upon the potato crop in practically every case; also that warm and dry weather is generally unfavourable, although there may be a good yield, when it is only moderately dry and warm. He also finds that cool weather is generally favourable, more especially when cool weather accompanies the wet weather. A cool and dry July has just as many yields above as below the normal. The combined weather conditions for the months of July and August have been worked out in the same manner. The result emphasises the fact that warm weather accompanied by dry weather for the whole two months is decidedly unfavourable; while good yields do sometimes result, even with warm weather, when there is a moderate amount of rain. Cool and wet weather for the two months is decidedly favourable.

METEOROLOGICAL OBSERVATIONS IN THE PERSIAN GULF.—In view of the naval and military operations which are taking place in the neighbourhood of the Persian Gulf, the following particulars on the climate of Bushire may be of interest. They are based on twenty-

six years' observations, and are taken from the "Meteorological Chart of the Indian Ocean" for August, 1915, published by the Meteorological Office. The most frequent winds are from north-west and west, forty-five per cent. of all winds blowing from these two directions. There are two per cent. of calms. The north-west winds predominate almost throughout the year, November and December being the only months when the prevailing direction is in another quadrant, and in these months the north-east winds are the most frequent. The mean air temperature in August is 90° F., the thermometer readings in the shade ranging from 115° to 69°. January is the coolest month of the year, and the hottest month is August. The thermometer in the shade exceeds 100° in each month from March to October, the highest reading being 115° in August. The lowest temperature recorded during the period is 38° in January, and in both December and February the thermometer has fallen to 39°. No rain was recorded in August during the twenty-six years, and there was practically no rain from May to September. The total average rainfall for the year is 11·77-in., which falls on about twenty-one days.

WHY SOME WINTERS ARE WARM AND OTHERS COLD IN THE EASTERN UNITED STATES.—Professor W. J. Humphreys, in a paper on this subject, shows that persistence during winter of the Bermuda "high" (or anticyclone) gives to the eastern United States a marine, and therefore for it an unusually mild climate; while continued absence of this "high" during winter allows a continental climate, and therefore exceptionally low temperatures, to extend quite to the Atlantic coast. The cause of the Bermuda "high" seems to be a cold-water surface, a minimum surface temperature, along the belts of "highs." This low-surface temperature in the region of the Bermudas may depend upon the temperature and strength of the Labrador current. Professor Humphreys points out that a knowledge of the surface temperature in the region of the Bermuda "high" probably would be of value to the American forecaster. It the Bermuda "high" is dependent upon the Labrador current, then proper gauging of this current should give some indication (during winter at least, and probably other seasons as well) a fortnight or a month ahead of the type of coming weather in the eastern United States. A persistent strong Labrador current would seem to indicate a subsequent development of a more or less equally persistent Bermuda "high," and through it the prevalence during winter of relatively warm weather throughout the eastern United States. On the other hand, a long-continued weak Labrador current would indicate subsequent absence of Bermuda "highs," and the prevalence over the eastern United States of unusually low temperatures.

AUSTRALIAN WEATHER, 1914.—An interesting "Rain Map of Australia" for the year 1914 has just been issued by the Commonwealth Weather Bureau. The numbered lines (isohyets) show the variations of the total rainfall, and the tinted portions represent the areas where the rainfall was above the normal amount. The seasonal variations are shown in a series of monthly charts printed on the reverse side of the map. Meteorologically, the year was most remarkable, the pressure distribution being very unusual, and, in fact, abnormal, during the winter to spring months. Interesting phenomena during the year were: Marked monsoonal activity in January; flood rain in the territory around Brock's Creek (sixteen inches in forty-eight hours) from the 3rd to the 5th; severe dust-storm at Port Pirie (South Australia) on the 7th, colliers being driven ashore; heavy local cyclones in Queensland from the 9th to the 16th; great heat inland on the 6th and the 7th, Bourke reaching 120°; heavy storm around Melbourne on the 28th. Heavy local storms in Queensland in February; cyclone at Cloncurry on the 13th; floods in Cairns district, 14th to 17th. Hurricane east of Suva on March 13th; phenomenal rainstorm and floods around Sydney from March 19th to 23rd. Record heavy April rains in Tasmania. The bad winter-spring drought over Southern Australia. Record heavy rainfalls in November and December over subtropical West Australia, and on the east coast of Tasmania in December; hurricane at Fiji on December 23rd.

The severe drought conditions of August, September, and October were absolutely disastrous, and resulted in a failure of the crops over the greater part of the wheat belt, a total harvest return of from twenty-nine to thirty millions of bushels only being anticipated, as compared with a production of nearly ninety-two millions of bushels during the previous season.

MICROSCOPY.

By F.R.M.S.

HOW BACTERIA WERE FIRST SEEN.—It is well known that the Dutch naturalist, Leeuwenhoeck, described micro-organisms which he had detected in water, vegetable infusions, the intestinal canals of various animals, and in the saliva and dental tartar. Some of these were plainly such as can be observed any day with moderate magnifications; but, on the other hand, it is hardly possible to doubt, after examining his descriptions and figures (which he communicated to the Royal Society from 1673 onwards) that he did really see bacteria (bacilli) and spirochaetes. It is stated that he used the simple microscope only. A description of his lens-holder will be found in Carpenter and Dallinger (Volume I, page 132, of the eighth edition). The subject of bacteriology seems to have remained where Leeuwenhoeck left it till about a century later, when the compound microscope was sufficiently improved to be of some service for the purpose. The organisms in question can be detected—hardly more—with a microscope of the Adams type, such as that shown in Dallinger's Figure 111 (*op. cit.*). I have used such an instrument many times, with the special object of finding out what could be seen in the pre-achromatic period. But I have always had a great difficulty in understanding how Leeuwenhoeck saw what he describes with a simple lens. I now suggest the following explanation. We are now accustomed to use the simple microscope as a direct accessory to the optical system of the eye: we hold it close to the eye, just as we hold the eye close to the ocular of the compound microscope. In the first case our "object" is the object itself; in the second, it is an aërial image of the object formed by the objective of the compound microscope. But we can, if we like, examine an object with the simple lens held at a considerable distance—say eighteen inches—from the eye. Doing this we get a normal, non-inverted image. It is of no service microscopically, because we could see just as much by looking at the object from a shorter distance, supposing that we have the requisite power of accommodation. But if, while we are still looking at the object through the lens from a distance of eighteen inches or so, we carefully withdraw the lens from the object in the direction of the eye, we find another point at which the image is visible; it is now, however, inverted and considerably magnified. What has happened is that we have extemporised a compound microscope: we are unconsciously looking at some point between the eye and the lens, and at this point we have produced an aërial image of the object. Normal loss of accommodation (Leeuwenhoeck was forty-eight when he published his "Arcana"), together with myopia, will greatly facilitate this experiment. Normal-sighted people can imitate it, or short-sighted people can increase their myopia, by wearing a convex glass for the purpose. In this case it is evident that the convex glass is functioning as the ocular of a compound microscope. Spectacles with biconvex glasses were commonly used in the seventeenth century by engravers and watchmakers, and doubtless also by minute anatomists. Leeuwenhoeck may have been

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accustomed to use them, or he may have been markedly myopic, or both myopic and (for the occasion) convex-spectacled. Though it has nothing to do with the formation of the aërial image, it contributes to the success of the experiment to have the direct light screened off round the lens which is acting as objective, as is done by the tube in the compound microscope. This would seem to be the reason for the flattened plate in the middle of which Leeuwenhoeck mounted his lenses. Another way of increasing the efficiency of the device is to darken the room, and work in the light admitted by a hole in a shutter, with a spherical flask in front of the hole to concentrate or "condense" the light. This, I am told, was quite a familiar device amongst the old etchers, so it is improbable that our author should have been unaware of it. I have found by experiment that a lens, mounted in a screen such as he used, gives remarkably good effects—rather better, on the whole, than those I obtained with my old Adams microscope mentioned above. Further, it would seem that in the case of liquid preparations Leeuwenhoeck used a nearly globular lens, and applied the liquid to the front surface of the lens itself. By this method one can undoubtedly see living bacteria. If these surmises with respect to his method of working are correct, Leeuwenhoeck anticipated the modern bacteriological microscope in all its essential features.

E. W. BOWELL.

PHOTOGRAPHY.

By EDGAR SENIOR.

THE PROPER MIXING OF CHEMICAL SOLUTIONS USED IN PHOTOGRAPHY.—The importance of seeing that solutions are properly mixed before they are used for the purpose for which they are intended has received very little attention on the part of photographers generally, although many defects in negatives and prints might be traced to neglect of proper precautions to ensure it. In the case of developers, a common practice is to add two stock solutions together in suitable proportions, and then make up to the desired quantity by the addition of water, with perhaps, "if considered necessary," a little potassium bromide as well. The developer is then considered as mixed and ready for use, although, as a matter of fact, the constituents are not at all intimately mixed; and if a solution of this kind is poured over an exposed plate some portions of the image will develop unevenly, although this unevenness may not be apparent in an ordinary negative, because of the general details hiding the defect; but in a negative from an object having a large surface of uniform tint in it the defect is at once noticeable, the developed plate showing the inequalities quite readily. The same thing is often encountered when developing bromide and other papers, especially when the paper is wetted before applying the developer. Some workers, with a view to ensure, as they suppose, a perfect mixing of the developer, pour it from the measure into the dish, and back again; and although this method does help the mixing, at the same time it tends to accelerate the oxidation of the developing solution, and in many cases leads to the formation of air-bells and spots in the negative. As a rule, a better plan to adopt is gently to stir the mixture with a glass rod. If we carefully consider the subject, we arrive at the conclusion that the mixing process must disperse the various ingredients throughout the whole volume of the solution; and, if time is not allowed for this diffusion, the solution will be streaky and not uniform. If alcohol, which is specifically lighter than water, be poured upon the latter, the liquids will gradually intermix; in spite of the difference of their specific gravities, they will diffuse into one another. As the results of investigations, the laws relating to diffusion, "when no porous diaphragm is used," are generally stated thus: First, when solutions of the same substance, but of different strengths, are mixed, the quantities diffused in equal times are proportional to the strengths of the solutions; second, in solutions which contain equal weights of different substances the quantities diffused will vary with the nature of the substances; third, the quantity diffused also varies with the temperature. Considering all the facts, the only way that the photographer can safely ensure the perfect mixing of his developing "or other" solutions is by the use of a proper mixing measure. This takes the form of a tall cylindrical measure, fitted with a stopper, preferably graduated, and holding just the quantity of solution required for use. Perfect mixing may then be brought about by reversing the measure several times, when on account of the measure not being quite full a large air-bubble would be formed; and this travelling up and down the flask would bring about a more perfect mixing than would be possible in any other way. This method of mixing solutions by means of a big air-bubble passing up and down a tubular measure is well known to chemists, and such measures, graduated either in the cubic centimetres or in ounces, can be obtained from dealers in chemical apparatus fairly cheaply. A further advantage of these stoppered measures lies in the fact that solutions will keep in them as well as in stoppered bottles; and it is always best to allow the solution to stand for a few minutes after mixing in order for diffusion to bring about a perfect admixture. All these precautions in the mixing of solutions may appear to most workers as quite unnecessary; but when we remember that a small quantity of potassium bromide is often added last to a developer, and that this has to become diffused throughout the entire volume of solution, the time necessary may be a fairly long one, unless some means be taken to aid proper mixing.

IMPROVING NEGATIVES FOR PRINTING.—Negatives which, from faulty development or other causes, are more or less imperfect in some parts may be considerably improved in many ways. For instance, suppose that the subject is one in which a heavy mass of foliage occurs in the foreground, together with a well-lit distance. Now in order to represent the distance correctly in the negative the foreground in many cases is almost entirely devoid of detail, and is shown in the print as a heavy black mass. In such a case, if the negative is coated (on the glass side) with matt varnish, containing a small amount of iodine dissolved in it (the quantity depending upon the circumstances of the case), heavy shadows in negatives can be made to print much lighter and the results improved to a great extent. The varnish, after it is applied, will dry in a few minutes, and then over the parts not required to be lightened it is removed with a penknife or a piece of rag, moistened with a little methylated spirit or benzole. The same means may be applied in the case of portraits and groups, only greater care is required in scraping away the varnish from the parts where it is not needed in order to prevent any marks from showing. Portraits taken out of doors frequently show very heavy shadows under the eyebrows and chin: these may be considerably lessened by applying a little colour (either red or blue) on the glass side of the negative, and then dabbing it with the finger, so as to form a kind of stipple caused by the texture of the skin. If carefully applied, the method is very satisfactory, and will be found greatly to reduce the heaviness of such shadows.

PHYSICS.

By J. H. VINCENT, M.A., D.Sc., A.R.C.Sc.

REFLEXION OF GAS MOLECULES.—It has often been assumed that when a gas molecule strikes a solid surface it rebounds in a direction independent of the angle of incidence, and that the number of molecules reflected in any given direction varies as the cosine of the angle which this direction makes with the normal to the surface. For the first time this matter has been tested experimentally

by R. W. Wood (*Phil. Mag.*, August, 1915). A jet of mercury vapour passing through a tube immersed in liquid air loses by condensation all the molecules in the jet, except those moving down the axis of the tube. This molecular ray is allowed to strike the reflecting surface of a solid, and the molecules after rebounding are caught by condensation on the inner walls of a cold vacuous bulb. The mercury deposit on this bulb shows that the cosine law is obeyed approximately when the angle between the normal and the reflected path is not large. At angles greater than 80° there appears to be no reflection. The original paper gives promise of the application of the subject thus opened up to the case of reflection from crystal surfaces and in other directions. Professor Wood has probably initiated an experimental method of great power.

ARTIFICIAL DAYLIGHT.—For the purpose of studying dyes, pigments, and the colours of natural objects in artificial light an approximation to daylight has long been sought. Dr. H. P. Gage has recently developed a glass filter which renders the light from a nitrogen-filled tungsten lamp almost like daylight. The spectrum curve for the light filtered through this daylight glass resembles very closely that for sunlight, especially in the region of the visible spectrum, which gives the greatest amount of useful light. The light thus filtered has been tested with microscopic objects stained with many different dyes, the slide being illuminated in turn by the artificial and real daylight. It was found to be impossible to detect any difference in the colours. For microscopic purposes the daylight glass is ground on both sides, the effect being like taking the light from a white cloud (S. H. Gage, *Science*, October 15th, 1915).

THE MAGNETIC PROPERTIES OF THE IRON-COBALT ALLOY. — The iron-cobalt alloy Fe_2Co was produced by Weiss in 1912, who found it had a saturation value of magnetisation ten per cent. higher than that of pure iron. Yensen has recently investigated the magnetic properties of this alloy, and compared it with pure electrically deposited iron fused in a vacuum furnace. It has a saturation value of magnetisation thirteen per cent. higher than that of pure iron. The values for the vacuum product, both for pure iron and for the alloy, are about three per cent. higher than for these substances melted under ordinary conditions. The permeability in medium fields is about twenty-five per cent. higher than that for pure iron. Iron-cobalt alloy is brittle but strong. Apart from its brittleness, it is not likely that the alloy will be put to practical use in electrical engineering at present owing to the high price of cobalt (Yensen, *The Electrician*, October 15th, 1915).

LENS AND DROP METHOD OF MEASURING REFRACTIVE INDEX.—If a few drops of liquid be introduced between a plane mirror and a thin convex lens, we have in effect a combination of the convex lens with a plano-concave lens of the liquid. From a knowledge of the curvature of the lower face of the convex lens, together with its focal length and that of the combination, the refractive index of the liquid can be calculated. By the choice of lenses of special curvature, and with the aid of totally reflecting prisms, Nettleton has adapted the method to the optical bench. By employing monochromatic light, and taking account of the thickness of the lenses, he has developed this into one of the most accurate and rapid means of determining refractive indices (*Proc. Phys. Soc.*, London, August, 1915).

THE REFLECTION OF ULTRA-VIOLET LIGHT BY METALS.—Hulburt has recently measured the reflecting power of many metals, alloys, and other substances for ultra-violet light. An ultra-violet spectrograph was set up, in which a sodium photo-electric cell connected with an electrometer served to measure the intensity of the incident and reflected light. The reflecting power for light of wave-lengths shorter than three thousand tenth-metres is rarely above fifty per cent., with one noteworthy exception, silicon, which showed a reflecting power of seventy-six per cent. in the region two thousand to three thousand. Brilliant opaque films of silicon were prepared by cathode sputtering. Metallic silicon possesses in a marked degree all the physical properties essential in a good reflector. It is as hard as ordinary glass without being brittle; it is not attacked by acids, and does not tarnish in air. The only reägents which attack it at ordinary temperatures are strong alkalis. The metal takes a brilliant polish by the ordinary method of polishing with pitch and rouge. The advantages of its use in optical instruments are obvious. (*Astrophysical Journal*, October, 1915.)

PRODUCTION OF LIGHT BY RUBBING.—When flint and steel are struck together the resulting sparks are hot enough to ignite tinder or to light a petrol lamp. The explanation of the effect is probably in this case fairly simple. The iron dust is hot enough to burn in the air, so that the energy necessary to obtain incandescence comes partly from the mechanical work expended and partly from the combustion of the iron in the air. Probably the same may be said of the brilliant display of sparks produced when uranium metal is ground on an emery wheel. But when we leave such cases, and consider the light produced by the crushing of sugar crystals, we come on to much more mysterious ground. Two bits of lump sugar, when struck together, give out a bright white light. This phenomenon was studied spectroscopically many years ago by Burke, who found that the light gave a continuous spectrum. Lankaster, in his "Diversions of a Naturalist," calls attention to the production of orange-coloured flames under water by rubbing quartz pebbles together. The quartz may be in the form of ordinary rock-crystal specimens, and the effects are surprisingly brilliant. The experiment is easily performed without any special precautions or apparatus, and will repay the reader for the trial.

RADIO-ACTIVITY.

By ALEXANDER FLECK, B.Sc.

THE EXPONENTIAL LAW AND THE GEIGER-NUTTALL RELATION.—In a recent paper, published by Dr. F. A. Lindemann in *The Philosophical Magazine*, a theory is put forward to account for the two relations mentioned above. It is doubtful, however, if it is necessary to make an endeavour to prove the exponential law, namely, that a constant fraction of a quantity of homogeneous radio-active matter changes per unit of time. When radio-activity has been found to be an atomic property the exponential law is at once explained. The case of the Geiger-Nuttall relation is entirely different. That relation can be represented by the equation $\log \lambda = A + B \log R$, where λ is the usual radio-active constant, and R the range of the α particle emitted. Lindemann makes the assumptions that the nucleus of an atom consists of separate particles in movement, and that when a certain number of these pass through some critical position in a short interval of time then the atom will become unstable, and will undergo that process which we know as disintegration. The short interval of time referred to is assumed to be the time for a strain to traverse the nucleus.

The theory possesses some valuable and helpful features, but before it can be generally accepted the number of assumptions made will have to be considerably reduced, or they will require to be supported by an amount of experimental evidence.

COLLOIDS AND THE RADIATION FROM RADIUM. —Two papers on this subject fall to be recorded. The first (Fernau and Pauli, *Biochem. Zeitsch.*, 1915, page 426) deals with the action of γ rays from 78·6 milligrams of radium on a selection of colloids, some inorganic and some biöcolloidal, *i.e.*, colloids met with in physiological chemistry. The changes taking place were measured by the change of viscosity in the colloid solution. The general results obtained

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were: (1) That the radiation caused the precipitation of electro-positive inorganic colloids; (2) that the rays had no effect on electro-negative colloids; and (3) that the radiation finally caused the coägulation of albumin.

The second paper (Nordensen, *Koll. Chem. Beihefte*, 1915, page 110) deals with colloidal solutions of metals, such as are often obtained when an electric arc is made to pass between rods of metal held below water. In an earlier paper the author has put forward the view that many metals form colloidal solutions when in contact with water, because the action of the oxygen dissolved in the water forms the metallic oxide, which then dissolves in a colloidal solution. In the paper under review it is shown that the function of the radium rays (among other forms of radiation) is to accelerate this oxidising action. If it happens that the particular metal is not acted on by such oxygen, then no colloidal solution is obtained, whether radium is in the neighbourhood or not.

This is another interesting example of the view put forward some months ago in this column, that radio-active energy has the general power of altering the rate at which any chemical action takes place.

EXPERIMENTS WITH POLONIUM.—Madame Curie and Debierne have recently been working with a very strong preparation of polonium. The object of the experiment was to carry out a redetermination of the amount of helium generated for every α particle sent out. It was found that 0·578 cubic millimetre of helium at N.T.P. was produced in five hundred and eighty-seven days from a preparation of polonium, which sent out $5{\cdot}99 \times 10^{10}$ α particles per minute.

Some further interesting observations were also made. In a spectroscopic photograph of the preparation it was seen that there was an unknown line of wave-length 4170·5, and this is ascribed to polonium. As time progressed this line disappeared, and concurrently the lines of lead became stronger. This is the first direct determination of the nature of radium G (the radium end-product), and is another conclusive proof of one of the earliest deductions in radio-activity, namely, that the final product of the uranium-radium series is an element having the same properties as lead.

PHOSPHORESCENCE.—The war has brought many inventions into public notice. One of the minor of these is the "radium watches," which have been supplied in great numbers to military people. In the cheaper varieties there is no radium or radio-active material, and the hands and figures are merely coated with a phosphorescent paint, such as zinc sulphide. These watches are only visible in the dark, provided that they have been exposed to light some short time previously. The more expensive watches have very appreciable radio-activity; and, although no instances have come to the writer's knowledge which contain radium, it is usually quite easy to detect the presence of thorium emanation. As these watches are guaranteed to retain their luminous properties for ten years, it is extremely likely that the active matter put on the dial is mesothorium. Along with this active material a phosphorescent substance is also mixed, so that, although these watches are permanently visible in the dark, the greater fraction of the luminosity when the watch is examined under those conditions after ordinary use in light is due to phosphorescence.

The phosphorescence of such materials as zinc sulphide is simply a matter of the amount of energy in the form of light absorbed and again emitted at a different rate. This type of phosphorescence is closely related to that possessed by such organism as glow-worms, although the phosphorescent material is entirely different. Luminous insects have recently been the subject of an article in *Nature* (December 9th, 1915) by K. G. Blair. Among his opening sentences that writer draws a picture of a large number of fish, which "inhabit the abysmal depths of the ocean where the sun's rays can never penetrate, carrying their own lamps disposed about their bodies in patterns that vary according to the species." It would be interesting to know if such fish were brought to the surface during daytime, and that it was only after that that they were phosphorescent when looked at in the dark. Before a definite statement could be made that these fish carried their own lamps, it would be necessary for them to be caught in the depths and examined without being exposed to light.

ZOÖLOGY.

By PROFESSOR J. ARTHUR THOMSON, M.A., LL.D.

EFFECT OF THYROID ON DIVISION RATE OF PARAMECIUM.—Waldo Shumway added thyroid emulsion and thyroid particles to the diet of the common slipper animalcule for over four hundred generations. The result was to increase greatly the rate of division. The ingestion of thyroid particles was observed, and digestion probably occurs. When the line was waning in vitality the effect of the thyroid ceased, perhaps because the infusorians were no longer able to digest the material.

A FLEA-BITE.—In his interesting account of some structural details in the rat-flea (*Ceratophyllus fasciatus*), which he had studied in hundreds of dissections, the late Professor E. A. Minchin called attention to the presence of many yeast-like bodies of several kinds in the salivary glands. It is supposed that these microbes are responsible for the local irritation and itching caused by the puncture of the flea's proboscis. The larval flea has larger and more active salivary glands, and this may be associated with its more or less omnivorous habits. The salivary secretion of the adult flea has probably, as in blood-sucking insects generally, the function of producing a secretion which prevents the ingested blood from coagulating.

FEEDING EXPERIMENTS ON TADPOLES.—Curious experiments by J. F. Gudernatsch (*Amer. Journ. Anatomy*, Volume XV, pages 431–78) go to show that in thyroid-fed tadpoles there is differentiation without growth, whereas in those fed on thymus (or spleen) there is growth without differentiation. It seems that the thyroid possesses a quality that stimulates differentiation, and the thymus (or spleen) a quality that suppresses differentiation. It is probable that in normal life they throw into the blood of the developing organism internal secretions with these antithetic capacities.

AUSTRALIAN FIRE-BEETLE.—It is said that when a bush-fire is raging certain Buprestid beetles (*Merimna atrata*) are attracted from a distance, perhaps by the scent, and "fly straight into the fire, alighting and running about on the hot, steaming branches, and sometimes even over the parts that are glowing red," yet without injury. Mr. H. M. Giles speaks of it as "one of the most agile species known to me, and as alert and active as an eagle." It is probable that the larvae feed on the half-burnt roots of the shrubs. The remarkable habit is paralleled among a number of "fire-bug" beetles which lay their eggs in burnt timber, "probably thus ensuring," as Professor Poulton suggests, "some chemical or physical advantage in the larval food."

STRUCTURAL UNITS.—It is well known that many organs of the body, such as liver and pancreas, are made up of the frequent and regular repetition of small masses of tissue. George W. Corner has recently defined such a structural unit as the smallest part of an organ, which is regularly repeated in a similar way throughout, and which contains the elementary constituents of the organs. Thus the structural unit of a pancreas will contain glandular tissue, duct, and blood-vessel; and there will be precisely the same length of blood-capillary for each structural unit. Corner finds that the pancreas of the adult pig is formed by the repetition, twenty to thirty thousand times, of a structural unit about one millimetre in diameter, and supplied by one arteriole.

GREGARIOUS HABIT OF HIBERNATING FLIES.—Professor E. B. Poulton calls attention to the large numbers of *Musca corvina* which may sometimes be found congregating together in hibernation. In a cistern-loft at St. Helens, Isle of Wight, he observed great patches of flies, usually in the angle between a rafter and the boarding. "Each of the largest assemblages must have included many hundreds of individuals." The examination of a sample of the semi-torpid flies showed that there were three hundred and four males and five hundred and fourteen females, not including twenty-three poor specimens.

RETURN OF CHIMNEY-SWIFT TO SAME SUMMER QUARTERS.—In an interesting report on bird-marking in North America Mr. Howard H. Cleaves cites the case of an adult chimney-swift (*Chaetura pelagica*) which fluttered down a chimney in Meriden, N.H., on June 7th, 1911. It was marked with a numbered ring and liberated. On June 15th, 1912, it came down the chimney again into the same room, and brought a companion with it! It had probably wintered in Central America, or elsewhere in the Tropics. The ring had not produced the least effect on the leg.

A MOUNTAIN BIOLOGICAL STATION. — The governors of Canterbury College, New Zealand, prompted by Dr. L. Cockayne and Professor Charles Chilton, have been wise enough to institute a small mountain biological station in the centre of the South Island, and to reserve an adjacent area of about two hundred acres. The laboratory is close to Cass Railway Station, at a level of one thousand eight hundred and fifty feet, and close to mountains of three thousand to five thousand feet high, with a rich Alpine vegetation. There are also lakes within easy reach. The outlook is more promising botanically than zoölogically, but there is considerable variety of insects, spiders, myriopods, and other invertebrates in the bush, and abundant plankton forms in the lake.

DO TWINS WRITE IN THE SAME WAY?—Professor E. L. Thorndike got seventy-two twin pairs of children (seven to fifteen years old) to write their first names and some common words. Each word was pasted on a card, and the cards were kept in two lots, corresponding to the twin pairs. Twelve men and women of good education, but of no special experience in identifying handwriting, were shown the seventy-two specimens belonging to seventy-two first members of twin pairs, and asked to match each by the specimen of the remaining seventy-two which most resembled it. There were for all the judges combined twelve chances of being right fortuitously; but fifty-eight correct pairings were made in all by the twelve. One case among the seventy-two pairs of twins showed a remarkably close resemblance in the handwriting, and was detected by eleven out of the twelve judges. In most cases the resemblance was not close.

CHIMPANZEE'S "NEST."—A young female chimpanzee in the Belle Vue Zoölogical Gardens, Manchester, has been observed by Mr. George Jenkinson to make a "nest" of straw and twigs. After gathering the twigs on the floor, she tucked a bundle of them between one leg and her thigh, dragging herself to her nest by her arms and the other leg. "The animal spends most of her time in the 'nest,' to which she carries all her food, even a cup of tea, which is taken up like the nesting material in the hollow of the thigh." Speaking on this subject at a recent meeting of the Zoölogical Society of London, Dr. C. C. Christy pointed out that it is somewhat misleading to talk of a chimpanzee's "nest." What is made in the African forest is a small sleeping platform of inbent twigs. These are usually close to the stem, and often comparatively low down, even within fifteen feet of the ground. They are never used a second night.

CLEANSING LIVING MUSSELS.—Dr. James Johnstone has recently made experiments in reference to the cleansing of living mussels from ingested sewage bacteria. The plan followed was to expose polluted mussels to sea-water during the last two hours or so of flood-stream and the first few hours of the ebb-stream—practically unpolluted water. In a few days the mussels have cleansed themselves, partly by the washing out of the bacteria and partly because the bacteria die in the fresher medium. Mussels may also be cleansed from ingested sewage bacteria by keeping them in water sterilised by the addition of chlorine. A concentration of chlorine in sea-water of five parts per million is sufficient practically to sterilise the water, while it does not interfere with the ordinary functions of the bivalves. Mussels can be cleansed in the laboratory in one day, to the extent of getting rid of ninety per cent. of their contained sewage organisms, by exposure to running sea-water, or to repeated changes of standing water dosed with chlorine. But there is urgent need to find out more about the micro-organisms of polluted water and of molluscs.

PIGMENT CELLS OF THE FROG'S SKIN.—The difficulty of perfectly accurate observation is well illustrated by the discrepant descriptions which are given of such familiar things as the black pigment cells of the frog. Some observers claim that the pigment cells are actively moving amoeboid cells; others say that they are fixed. Some say that the chromatophore is a fixed stellate cell, within which the pigment, carried in a rather fluid cytoplasm, streams into and out of the processes during contraction and expansion; others say the pigment flows in special intracellular canaliculi. According to some, the viscous pigment-bearing endoplasm is injected into the branches of a firmer ectoplasm; according to others the pigment cells expand and contract like amoebae in intercellular spaces.

Dr. Davenport Hooker, in a recent investigation, finds that the pigment cells or melanophores, lie in preformed spaces in the corium, or under-skin, and in the adults, fill the branches of these spaces. The pattern is prescribed by the preformed spaces. Within these spaces the cells expand and contract by means of pseudopodia, and therefore deserve to be called amoeboid.

PROLONGED INCUBATION IN PIGEONS.—Messrs. Leon J. Cole and William F. Kirkpatrick find that the mean time of hatching of the first egg in pigeons is 16·5 days after the laying of the second, and that the mean time of hatching of the second is seventeen days after it is laid. As the mean interval between the laying of the two eggs is practically forty-four hours, the time from laying to hatching of the first egg is nearly a day and a half longer than it is for the second egg, this being probably due to the fact that the first egg receives very little attention until the second is laid.

When the eggs do not hatch the birds may continue to sit for about six days after the normal period. This facultative lengthening out of the incubation instinct is adaptive, since the total period required for hatching is variable. There is what the observers call a "factor of safety." In the wild mourning dove (*Zonaidura macroura carolinensis*) the period of incubation is thirteen days from the time of laying the second egg. Two eggs of the ring dove (*Turtur risorius*), with dead embryos, were substituted for the eggs of the mourning dove, which were placed in an incubator. The parent birds continued to sit on the substitute eggs for four days after their own eggs had hatched, so Raspail was mistaken in his assertion that wild birds have "an exact notion of the time required for the eggs to hatch." The eggs were deserted after 8.30 in the morning and before 10.30; and, if the division of incubating labour in the mourning dove is similar to that of domestic pigeons (the male sitting from about 10 a.m. to 2 or 3 p.m.), "this probably means that it was the male bird which first failed to continue the extended incubation of the refractory eggs."

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THE FACE OF THE SKY FOR FEBRUARY.

By A. C. D. CROMMELIN, B.A., D.Sc., F.R.A.S.

TABLE 67.

Date.	Sun.		Moon.		Mercury.		Venus.		Mars.		Jupiter.		Saturn.		Neptune.	
	R.A.	Dec.	R.A.	Dec.	R.A.	Dec.	R.A.	Dec.	R.A.	Dec.	R.A.	Dec.	R.A.	Dec.	R.A.	Dec.
Greenwich Noon.	h. m.	°	h. m.	°	h. m.	°	h. m.	°	h. m.	°	h. m.	°	h. m.	°	h. m.	°
Feb. 5	21 11·3	S. 16·2	22 41·7	S. 5·3	21 5·6	S. 12·9	23 25·5	S. 4·9	9 43·2	N. 18·5	23 56·5	S. 1·6	6 46·2	N. 22·6	8 12·2	N. 19·7
„ 10	21 31·4	14·7	2 46·1	N. 21·5	20 43·7	14·5	23 47·5	S. 2·3	9 35·3	19·2	0 0·4	1·2	6 45·0	22·6	8 11·6	19·7
„ 15	21 51·0	13·0	7 7·0	N. 24·6	20 32·6	16·0	0 9·3	N. 0·3	9 27·3	19·8	0 4·4	0·8	6 43·9	22·7	8 11·1	19·7
„ 20	22 10·4	11·3	11 6·6	N. 2·1	20 34·3	17·0	0 30·9	2·9	9 19·7	20·3	0 8·4	S. 0·3	6 43·0	22·7	8 10·6	19·8
„ 25	22 29·5	S. 9·5	15 21·0	S. 23·6	20 45·9	S. 17·3	0 52·5	N. 5·5	9 12·7	N. 20·7	0 12·6	N. 0·1	6 42·3	N. 22·7	8 10·1	N. 19·8

TABLE 68.

Date.	Greenwich Noon.																Midnight.	
	Sun.			Mars.					Jupiter.								Moon.	
	P	B	L		P	B	L	T	P	B	L_1	L_2	T_1	T_2			P	
	°	°	°		°	°	°	h. m.	°	°	°	°	h. m.	h. m.			°	
Feb. 5 ...	−13·6	−6·3	212·6	Feb. 6 ...	+ 4·7	+16·5	12·2	11 10 *m*	Feb. 5 ...	−25·4	+2·0	333·7	139·2	10 34 *e*	6 6 *e*		Feb. 5	−21·7
„ 10 ...	15·5	6·6	146·8	„ 12 ...	3·3	15·9	320·0	2 44 *e*	„ 12 ...	25·4	2·0	357·2	109·3	9 56 *e*	6 55 *e*		„ 10	−16·0
„ 15 ...	17·3	6·9	81·0	„ 18 ...	1·9	15·3	267·6	6 19 *e*	„ 19 ...	25·4	2·0	20·6	79·3	9 17 *e*	7 45 *e*		„ 15	+ 7·5
„ 20 ...	18·9	7·0	15·1	„ 24 ...	+ 0·6	+14·8	215·0	9 54 *e*	„ 26 ...	25·3	2·1	44·0	49·3	8 39 *e*	8 34 *e*		„ 20	+22·2
„ 25 ...	−20·4	−7·2	309·3						Mar. 4 ...	−25·3	+2·1	67·5	19·3	8 0 *e*	9 24 *e*		„ 25	+12·9

P is the position angle of the North end of the body's axis measured eastward from the North point of the disc. B, L are the helio-(planeto-)graphical latitude and longitude of the centre of the disc. T is the time of transit of the zero meridian across the centre of the disc. In the case of Jupiter System I refers to the rapidly rotating equatorial zone; System II to the temperate zones, which rotate more slowly. To find intermediate passages of the zero meridian of either system across the centre of the disc, apply to T_1 T_2 multiples of $9^h\ 50^m \cdot 7$, $9^h\ 55^m \cdot 8$ respectively. In the case of Mars apply multiples of $24^h\ 36^m$.

The data for the Moon in the Second Table are given for Greenwich Midnight, *i.e.*, the Midnight at the end of the given day. Those for the planets were given for midnight last year, but are now given for Noon.

The letters *m*, *e* stand for morning, evening. The day is taken as beginning at midnight.

THE SUN is moving Northward with increased speed. Its semi-diameter diminishes from 16′ 15″ to 16′ 10″. Sunrise changes from $7^h\ 43^m$ to $6^h\ 49^m$; sunset from $4^h\ 45^m$ to $5^h\ 37^m$. There is now considerable solar activity, and a constant watch should be kept on the disc.

MERCURY is in inferior conjunction with the Sun on the 5th. It then becomes a morning star, reaching greatest elongation, 27° West of Sun, on March 1. Semi-diameter decreases from 5″ to 3½″. Illumination zero on 5th, half disc at end of month.

VENUS is an evening star, well placed for observation. Semi-diameter 7″. Illumination four-fifths. 27′ North of Jupiter, $14^d\ 2^h\ m$. It is interesting to compare the brightness of the two planets when near each other.

THE MOON.—New $3^d\ 4^h\ 6^m\ e$. First quarter $10^d\ 10^h\ 20^m\ e$. Full $19^d\ 2^h\ 29^m\ m$. Last quarter $26^d\ 9^h\ 24^m\ m$. Perigee 1^d midnight and $29^d\ 9^h\ e$. Apogee $13^d\ 9^h\ e$, semi-diameter 16′ 34″, 16′ 19″, 14′ 46″ respectively. Maximum librations 7^d 7° W., 9^d 7° S., 21^d 6° E., 24^d 7° N. The letters indicate the region of the Moon's limb brought into view by libration. E., W. are with reference to our sky, not as they would appear to an observer on the Moon. (See Table 69.)

TOTAL ECLIPSE OF THE SUN, FEBRUARY 3RD.—Details of the track of totality were given in Notes on Astronomy last month. A partial eclipse is visible in the British Isles, Western France, Spain, N.W. Africa, Iceland, Greenland, most of North America, and the northern half of South America. In the British Isles the Sun will set eclipsed. At Greenwich the eclipse begins at $4^h\ 31^m\ e$; it will begin 4^m earlier at Dublin, Armagh, and Edinburgh. At Greenwich first contact occurs 242° from North Point towards East. Sunset is at $4^h\ 49^m$, about a quarter of the Sun being eclipsed. As one proceeds West from Greenwich, sunset becomes later and the amount of the Sun eclipsed at sunset increases. At Land's End nearly two-thirds of the Sun are eclipsed at sunset; in South West Ireland about nine-tenths of the Sun are eclipsed.

MARS moves from Leo to Cancer. It is in opposition on 10th, $2^h\ m$; nearest Earth. Semi-diameter 7″, illumination Full. The North Pole of the planet is now turned towards the Earth and Sun. The Vernal Equinox of the planet's northern hemisphere took place on October 19th, and the planet is in the part of its orbit that corresponds with the middle of May on Earth. The present opposition is unfavourable as regards distance, but favourable as regards altitude.

JUPITER is an evening star in Pisces; it is drawing too near to the Sun for convenient observation. Near Venus on 14th. Equatorial diameter 34″, Polar 32″. Defect of illumination on East Limb, 0″·1.

TABLE 69. Occultations of Stars by the Moon visible at Greenwich.

Date.	Star's Name.	Magnitude.	Disappearance.		Reäppearance.	
			Time.	Angle from N. to E.	Time.	Angle from N. to E.
1916.			h. m.	°	h. m.	°
Feb. 6 ...	22 Piscium	5·8	8 39 *e*	105	—	—
,, 7 ...	136 B Piscium	6·5	9 27 *e*	20	10 6 *e*	293
,, 10 ...	WZC 189	6·9	11 53 *e*	49	—	—
,, 14 ...	139 Tauri	4·7	2 46 *m*	138	3 29 *m*	240
,, 14 ...	ϵ Geminorum	3·2	11 3 *e*	112	0 19 *m**	280
,, 15 ...	WZC 476	6·7	4 44 *m*	149	—	—
,, 15 ...	BD+23°·1744	6·4	9 10 *e*	125	10 29 *e*	270
,, 17 ...	81 Cancri	6·4	9 33 *e*	132	10 53 *e*	288
,, 19 ...	35 Sextantis	6·1	7 56 *e*	113	9 2 *e*	302
,, 21 ...	431 B Leonis	6·2	1 52 *m*	84	2 48 *m*	350
,, 22 ...	WZC 805	6·7	—	—	4 8 *m*	355
,, 22 ...	BD−8° 3366	7·0	—	—	6 21 *m*	355
,, 25 ...	WZC 955	6·8	—	—	6 15 *m*	290
,, 26 ...	Lacaille 6719	6·9	—	—	6 8 *m*	251
,, 27 ...	95 G Ophiuchi	6·1	4 22 *m*	60	5 20 *m*	312
,, 27 ...	Lacaille 7175	7·0	—	—	6 9 *m*	310

From New to Full disappearances take place at the Dark Limb, from Full to New reäppearances.
The asterisk indicates the day following that given in the date column.

Configuration of satellites at $6^h\ 30^m$ *e* for an inverting telescope.

JUPITER'S SATELLITES.

Day.	West.	East.	Day.	West.	East.
Feb. 1	432 ○	1	Feb. 16	3412 ○	
,, 2	431 ○	2●	,, 17	43 ○	12
,, 3	43 ⊙	2	,, 18	41 ⊙	3
,, 4	42 ○	13	,, 19	421 ○	3
,, 5	421 ○	3	,, 20	4 ○	123
,, 6	○	123 4●	,, 21	41 ○	32
,, 7	1 ⊙	24	,, 22	432 ○	1
,, 8	32 ○	14	,, 23	312 ○	4
,, 9	312 ○	4	,, 24	3 ○	124
,, 10	3 ○	124	,, 25	1 ○	24 3●
,, 11	2 ○	34 1●	,, 26	2 ⊙	34
,, 12	21 ○	34	,, 27	○	1234
,, 13	○	1234	,, 28	1 ○	324
,, 14	1 ○	342	,, 29	23 ○	14
,, 15	324 ○	1			

The following satellite phenomena are visible at Greenwich all in the evening hours:—$2^d\ 8^h\ 25^m$ I. Oc. D., $8^h\ 47^m\ 38^s$ II. Ec. R.; $3^d\ 5^h\ 37^m$ I. Tr. I., $6^h\ 34^m$ I. Sh. I., $7^h\ 51^m$ I. Tr. E., $8^h\ 47^m$ I. Sh. E.; $4^d\ 6^h\ 4^m\ 44^s$ I. Ec. R.; $6^d\ 5^h\ 27^m$ IV. Oc. D., $8^h\ 20^m$ IV. Oc. R.; $7^d\ 5^h\ 27^m$ III. Tr. I., $8^h\ 24^m$ III. Tr. E.; $9^d\ 6^h\ 54^m$ II. Oc. D.; $10^d\ 7^h\ 39^m$ I. Tr. I., $8^h\ 30^m$ I. Sh. I.; $11^d\ 6^h\ 12^m$ II. Sh. E., $7^h\ 59^m\ 48^s$ I, Ec. R.; $12^d\ 5^h\ 12^m$ I. Sh. E.; $18^d\ 5^h\ 52^m\ 25^s$ III. Ec. R., $6^h\ 7^m$ II. Sh. I., $6^h\ 58^m$ I. Oc. D., $7^h\ 24^m$ II. Tr. E.; $19^d\ 6^h\ 26^m$ I. Tr. E., $7^h\ 8^m$ I. Sh. E.; $25^d\ 7^h\ 28^m$ II. Tr. I.; $26^d\ 6^h\ 14^m$ I. Tr. I., $6^h\ 50^m$ I. Sh. I.; $27^d\ 6^h\ 2^m\ 3^s$ II. Ec. R., $6^h\ 18^m\ 25^s$ I. Ec. R.

The Eclipse reäppearances of Satellites I., II., and both phases of those of III., occur low right of the disc in an inverting telescope, taking the direction of the belts as horizontal.

SATURN was in opposition on Jan. 4th; it is in Gemini. Rises before sunset. Angle P−6°·8, B−25°·6. Polar semi-diameter $9\frac{1}{3}''$, Major axis of ring $45\frac{1}{3}''$, minor $19\frac{1}{3}''$. Eastern elongations of Tethys (every fourth given) $8^d\ 2^h\cdot3\ m$, $15^d\ 3^h\cdot6\ e$, $23^d\ 4^h\cdot8\ m$; of Dione (every third given) $5^d\ 10^h\cdot9\ m$, $13^d\ 3^h\cdot9\ e$, $21^d\ 8^h\cdot9\ e$; of Rhea (every second given) $9^d\ 11^h\cdot6\ m$, $18^d\ 0^h\cdot3\ e$, $27^d\ 1^h\cdot1\ e$. For Titan and Japetus E., W. stand for Eastern and Western elongations; S., I. for Superior and Inferior Conjunctions. Titan $7^d\ 1^h\cdot7\ m$ E., $14^d\ 5^h\cdot2\ e$ W., $22^d\ 11^h\cdot7\ e$ E. Japetus $3^d\ 10^h\cdot3\ e$ S., $24^d\ 10^h\cdot5\ m$ E.

URANUS is invisible. It is in conjunction with the Sun on the 5th.

NEPTUNE was in opposition on Jan. 22nd in Cancer. Semi-diameter 1″, magnitude 7·7.

TABLE 70. LONG-PERIOD VARIABLE STARS.

Star.	Right Ascension.	Declination.	Magnitudes.	Period.	Date of Maximum.
	h. m. s.	° ′		d.	
RX Cephei	0 43 9	+81 30	7·4 to 7·9	130	1916—Feb. 16
W Androm.	2 12 11	+43 55	7·0 to 13·8	395	,, Mar. 10
R Triang.	2 31 53	+33 53	5·3 to 12·0	265	,, Mar. 3
T Arietis	2 43 35	+17 9	7·4 to 9·7	313	,, Feb. 14
U Arietis	3 6 20	+14 28	7·2 to 13·8	371	,, Mar. 9
V Cancri	8 16 53	+17 34	7·1 to 12·8	272	,, Jan. 31
W Cancri	9 4 56	+25 36	7·4 to 14·0	385	,, Mar. 1
R Virginis	12 34 12	+ 7 27	6·2 to 11·1	145	,, Feb. 19

Special attention is called to the Maximum of Mira Ceti. χ Cygni should also be watched. See last month's Table.
Minima of Algol $3^d\ 3^h\cdot6\ m$, $6^d\ 0^h\cdot4\ m$, $8^d\ 9^h\cdot2\ e$, $11^d\ 6^h\cdot0\ e$, $23^d\ 5^h\cdot4\ m$, $26^d\ 2^h\cdot2\ m$, $28^d\ 11^h\cdot0\ e$. Period $2^d\ 20^h\ 48^m\cdot9$.
Principal Minima of β Lyrae $13^d\ 2^h\cdot2\ e$, 26^d noon. Period $12^d\ 21^h\ 47^m\cdot5$.

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METEOR SHOWERS (from Mr. Denning's List):—

Date.	Radiant. R.A.	Radiant. Dec.	Remarks.
Feb. 5–10 ...	75°	+ 41° N.	Slow, bright.
„ 15 ...	236°	+ 11° N.	Swift, streaks.
„ 15 ...	261°	+ 4° N.	Swift, streaks.
„ 20 ...	181°	+ 34° N.	Swift, bright.
„ 20 ...	263°	+ 36° N.	Swift, streaks.

GREENWICH TIMES OF MERIDIAN TRANSIT OF CERTAIN BRIGHT STARS.—These are given to facilitate the determination of time by observations with small transit instruments. The times for intermediate days may be obtained by simple interpolation. The Greenwich time of the stars crossing the meridians of other places may be obtained by expressing the longitude of these places in time, diminishing them by 9s·83 per hour, and proportionately for fractions of an hour, then applying the result to the tabular time—positively for West longitudes, negatively for East ones.

TABLE 71.

Day.	Aldebaran. N. Dec. 16° 21′.	Sirius. S. Dec. 16° 36′.	α Cancri. N. Dec. 12° 11′.
	h. m. s.	h. m. s.	h. m. s.
Jan. 30	7 56 13·26 *e*	10 6 12·90 *e*	0 18 18·68 *m**
Feb. 9	7 16 54·03 *e*	9 26 53·72 *e*	11 38 59·66 *e*
„ 19	6 37 34·79 *e*	8 47 34·52 *e*	10 59 40·60 *e*
„ 29	5 58 15·54 *e*	8 8 15·28 *e*	10 20 21·50 *e*

* Morning of Jan. 31st.

SUN after clock Feb. 1, 815s·71, Feb. 6, 850s·09, Feb. 11, 863s·97, Feb. 16, 858s·04, Feb. 21, 833s·81; Feb. 26, 793s·34, Mar. 2, 738s·82. These are the equations of time for the moment of solar transit at Greenwich.

VARIABLE STARS.—Stars reaching their maxima in or near February, 1916, are included. The lists in recent months may also be consulted. (See Table 70.)

CEYLON PLUMBAGO.

AT the end of 1914 the important plumbago-mining industry in Ceylon was suffering very severely from the loss of the German and Belgian markets, and from other causes connected with the war, and steps were taken by the Imperial Institute to induce users of plumbago in the United Kingdom to buy the whole of their supplies from Ceylon, instead of partly from Ceylon and partly from foreign countries as previously.

Recent statistics indicate that progress has already been made in this direction, for it is significant that the percentage of Ceylon plumbago exported to the United Kingdom during the first ten months of the past year was considerably greater than in 1913. Moreover, the total exports to this country from January to October last year were more than double those of the corresponding months in 1914, and, in addition, Russia was a large new purchaser.

The most important use of plumbago is in the manufacture of steel works crucibles, which are required to resist the effects of great variations of temperature, and it is gratifying to know that a source within the British Empire is available to supply the demands of our munitions works for the article in question.

CORRESPONDENCE.

A NEW COMET.

To the Editors of " KNOWLEDGE."

SIRS,—I send you, under separate cover, a print from a photograph of the region of Belt of Orion, published by you some years ago, and taken by Mr. A. Smith, Dalbeattie, on February 2nd, 1902. Exposure, two hours forty minutes. (See Figure 14.)

On this print I have plotted the positions of a comet which I discovered on November 22nd, but which I did not recognise as such until the 24th, when it formed the central point of a W, the other points being four small stars. On the 29th it was central between the two crowns of small stars near 31 Orionis. Bad weather prevented observation between November 25th and 28th. The comet was observed and photographed on December 2nd from my positions by the Royal Observatory here, and by Messrs. Innes and Woods, of the Union Observatory, Johannesburg. On this date its approximate daily motion was about nine minutes north and eighteen to twenty seconds west. Since then it has increased its motion considerably, and has also brightened to about 9th to 10th magnitude. At discovery I estimated it at about 11th magnitude.

In my ten and a quarter-inch reflector, with comet eyepiece of thirty-inch field, the comet shows a distinct tail and minute bright nucleus. On the 8th inst. it was about 6′ south, and on 9th (last night) about 5′ north of V.A. 74, the position of which is given as R.A. 5h. 20m. 0·8s., Dec. 20′ north.

Owing to the comet's slow motion, particularly from date of discovery to November 29th, it must be at a very great distance, and, of course, at present quite outside the orbit of the Earth, so we may hope for some good view in months to come.

CLEMENT JENNINGS TAYLOR, F.R.A.S.

"HERSCHEL VIEW,"
CLAREMONT,
CAPE TOWN, S.A.
December 10th, 1915.

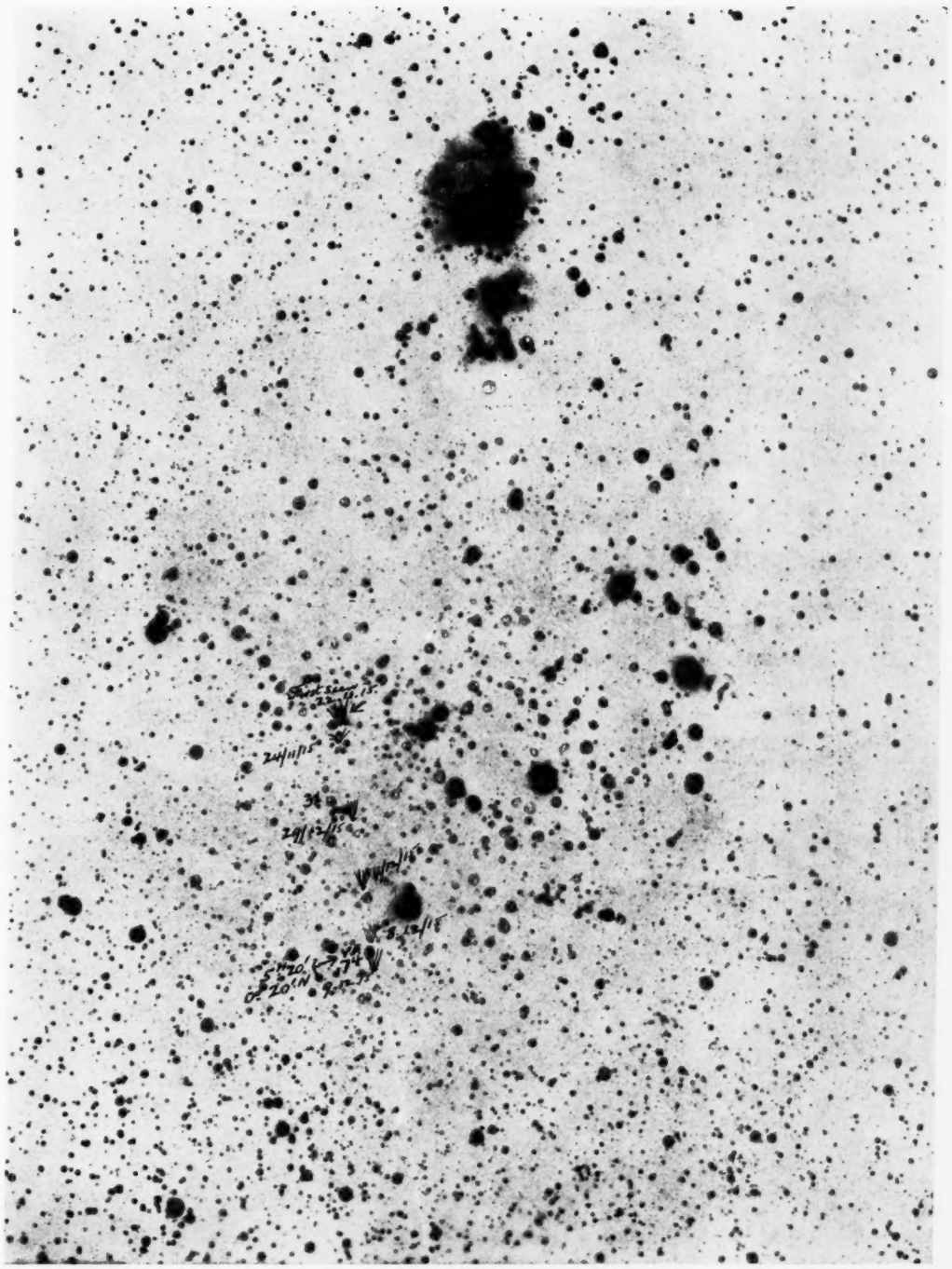

FIGURE 14.

Path of the Comet, discovered by Mr. C. J. Taylor, from the 22nd November to the 9th December, 1915.

Projected on a print from a photograph taken by A. Smith, Dalbeattie, 2nd July, 1902.

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FIGURE 15. Mr. Williamson about to kill a shark.

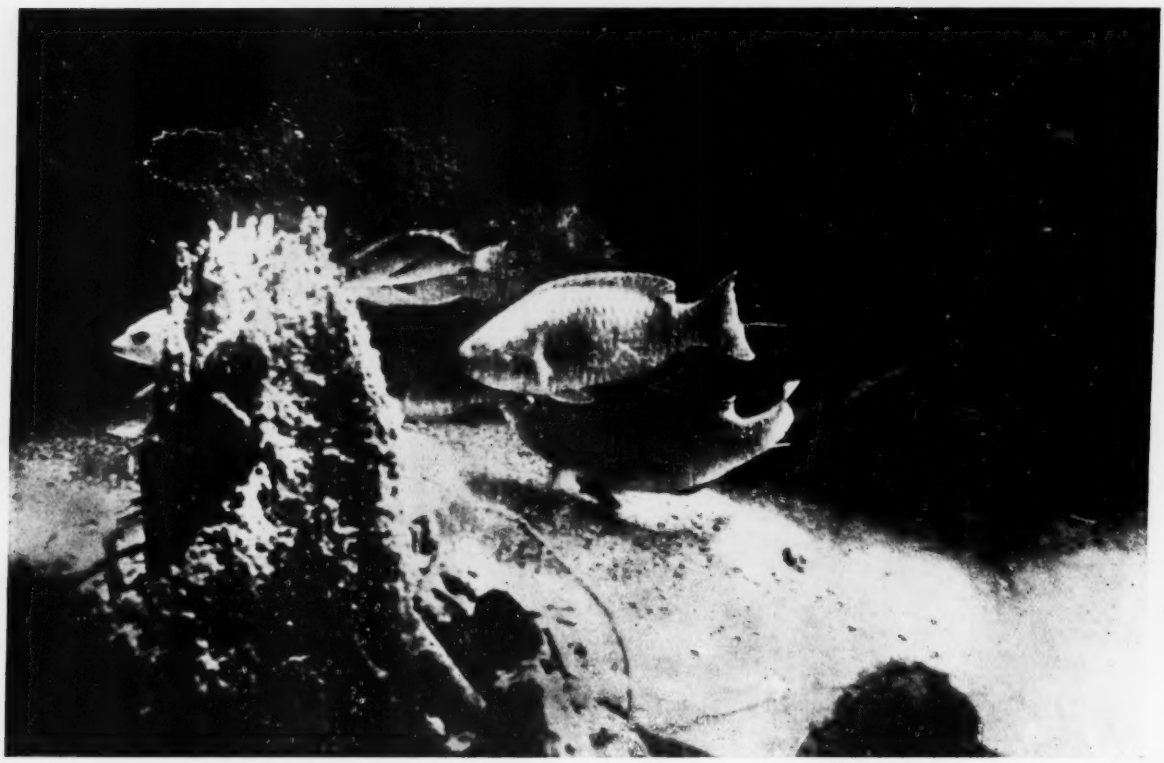

FIGURE 16. Fishes from a kinematograph film taken under the sea by the Williamson Expedition.

THE KINEMATOGRAPH UNDER THE SEA.

THERE is now being exhibited at the Philharmonic Hall a number of kinematograph films taken under the sea in the Bahamas by the Williamson Expedition. The apparatus which made it possible for them to be obtained was developed from an idea of a British captain, Charles Williamson, by his two sons, and was originally intended to afford a means of going to the bottom of the sea for the purpose of securing sponges or pearls or treasure from wrecks.

Figure 17 is a diagrammatic representation of the apparatus. It consists of a long flexible tube, three feet wide, in short lengths, which can be added or removed according to the depth required. It is made of overlapping steel scales or plates, hinged together between circular bands of iron. These are about a foot apart, and form the skeleton of the tube. Over the metal part is a water-proof covering of canvas and rubber.

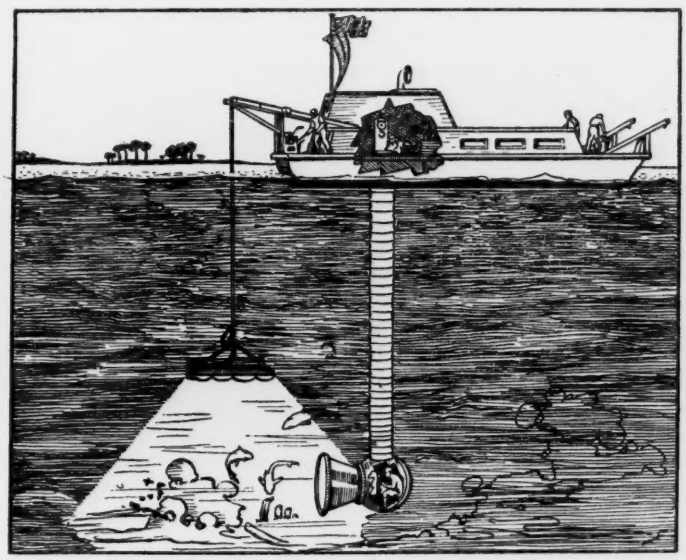

FIGURE 17. Diagrammatic representation of the Williamson apparatus used for taking kinematograph films under the sea.

At the bottom of the tube is a spherical observation chamber, five feet in diameter, which is provided with a large funnel-shaped prolongation on one side, at the end of which there is a glass window. Through this, photographs were taken as an experiment, and afterwards the films to which we have alluded.

A battery of Cowper-Hewitt mercury-vapour lamps was provided, but these were only necessary for use at night; for the sun was so brilliant and the water so clear that the kinematograph camera could be used even at depths of eight or ten fathoms. Any danger of the observation chamber being broken is obviated by keeping the pressure of the air inside exactly the same as the water pressure out, two gauges—one for water and one for air—being provided to render this easy. The whole apparatus is let down from a barge specially constructed for the purpose.

Many interesting pictures of fishes and the fauna and flora of the bed of the sea were obtained (see Figure 16). One observer in the chamber works the camera, and another gives orders up the tube, so that the chamber can be raised or lowered or moved sideways as required.

One might mention also that good results were obtained of natives diving for pennies, and some more sensational pictures were taken of Mr. Ernest Williamson killing a shark (see Figure 15), a native diver having previously done the same, but unfortunately not within the field of the camera.

It should be recorded that some of the pictures were taken at a depth of as much as one hundred and fifty feet.

It is interesting to mention how it was that Captain Williamson came to think of his invention. During a heavy gale off Cape Hatteras some years ago, his ship strained her side-seams near the water-line. Every time she rolled the water rushed in, and it was evident that they would have to be closed up at once if the ship was to be saved.. Captain Williamson was therefore lowered over the side in a long canvas bag, which had sleeves, through which he could put his hands in order to work, and a glass window, so that he could see what he was doing.

For examining wrecks and for obtaining objects from the bottom of the sea a special chamber has been devised for use at the end of the tube, from which the hands can be protruded, and which is supplied with a receptacle from which tools may be taken or into which objects may be put. It will be seen that there is very considerable scientific interest attaching to the films which are still on view, and we would recommend our readers to take an opportunity of going to see them.

THE AGASSIZ ASSOCIATION.

THE Association which perpetuates the memory of Agassiz in America has now been in existence for forty years. From the Charter of Incorporation we learn that the objects are the promotion of scientific education; the advancement of science; the collection in museums of natural and scientific specimens; the employment of observers and teachers in the different departments of science; and the general diffusion of knowledge.

In a good many ways it is therefore the equivalent of what the Selborne Society is in this country. Its local collection of members are, however, called "Chapters," instead of "Branches" and "Junior Branches." At its headquarters, at Arcadia, Sound Beach, Connecticut, there is a general Natural History Institution. It consists of the beautiful Agassiz Grove, a well-equipped reception room, a Nature Study park, more than a hundred acres of wild forests and thickets which are explained and explored under personal guidance. Besides this, demonstrations are given in the apiary; instruction in the Biological Laboratory, and exhibitions with a projection microscope. It is hoped, too, soon to add an Astronomical Observatory with a six-inch telescope. This will be the only one probably dedicated to the free use of the public. In addition the Agassiz Association publishes observations and answers questions. Its official organ is *The Guide to Nature*, which is edited by Mr. Edward E. Bigelow, the President of the Association.

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THE GREAT ALASKAN EARTHQUAKES OF 1899.

By CHARLES DAVISON, Sc.D., F.G.S.

(*Continued from Volume XXXVIII, page 172.*)

BESIDES these great lines of inferred faulting, there are in several places series of visible minor faults. The finest series occurs on a hill close to the lower end of Nunatak Glacier. The southern summit of this hill is broken by a series of small parallel faults the scarps of which divide the hilltop and side into a series of parallel steps with a trend of N. 40° W. There are scores of such faults, varying in length from a few feet to several hundred yards and separated by distances of from two to ten feet. The scarps are usually vertical, and vary in height from an inch or less to as much as eight feet, the average being about a foot. There is, of course, no proof of the connection of these minor faults with the great faults inferred above, but there can be little doubt that they were formed during the earthquakes of 1899. In 1905, the edges of the scarps were sharp, and the talus-slopes at their bases were either small or absent. In 1909 and 1910 the weathering of the scarps was more advanced, and some of the smaller scarps were already mantled by talus-slopes.

We may now summarise the nature of the displacements which gave rise to the series of earthquakes. The principal movements took place practically within one month. With regard to the origin of the earthquake of September 3rd there is some doubt. The movements which caused the other earthquakes up to September 10th, about noon, were probably at some depth. They do not appear to have caused any surface dislocations. The greater part, if not all, of the superficial uplift occurred with, and indeed caused, the second great earthquake of September 10th, and took place along several main lines of fracture and secondary faults. These faults divide up the crust into at least three, and perhaps more, distinct blocks the known sides of which are roughly parallel. The first block is bounded on three sides by the faults A, B, C, and E (Figure 318), and extends an unknown distance towards the south-east; the second block is bounded towards the east and south by the faults C and G, and extends an unknown distance towards the west; the third includes the north-east shore of the main portion of Russell Fiord and extends an unknown distance towards the north-east.

All of these blocks were uplifted with respect to the level of the sea. The uplift, however, was accompanied by other movements. On the west side of the fault or faults, A, B, there was a noticeable depression. In many parts, and probably in more cases than were actually seen, were a number of minor faults, due apparently to local adjustments in the tilted blocks. There can be little doubt that some of the differences in the amount of uplift in adjoining areas should be attributed to these small differential adjustments.

"From such great and complex crustal movements as are so clearly proved in this region it is easy," Messrs. Tarr and Martin remark, "to understand the complex phenomena observed. That such movements should produce world-shaking earthquakes follows almost of necessity; and that the number of minor shocks should be numbered by the hundreds is likewise a necessary result of so complex a shattering of the earth's crust. While it is possible that some of the shaking had its source outside of the Yakutat Bay region, the phenomena in that region seem by themselves amply sufficient to account for it all."

EFFECTS OF THE EARTHQUAKES ON GLACIERS.

The changes of level manifested during the Alaskan earthquakes are noteworthy for their unprecedented magnitude and for the complex movements along several or many faults. But, except in these respects, they do not differ from the fault-displacements of other earthquakes. One effect of the Alaskan earthquakes on glaciers seems, however, to be unique; and in showing how earthquakes may give rise to a general advance in the glaciers of a large and mountainous district Messrs. Tarr and Martin have thrown light on a difficult problem of glacial geology.

The shattering of glaciers and the discharge of icebergs were the first and most evident effects of the earthquakes. Not only in Disenchantment Bay, but even one hundred and fifty miles to the east in Glacier Bay, this shattering occurred. The well-known Muir Glacier in that bay suffered more

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than most glaciers. It is doubtful whether its total retreat of eight and a half miles in the thirteen years 1894 to 1907 is to be attributed entirely to the earthquakes, but it is certain that the icebergs shed from its front so clogged the inlet as to render it inaccessible to steamships until 1907.

Advance of the Yakutat Bay Glaciers.—In past times there have been two general advances of the glaciers of Yakutat Bay. During the earlier advance the glaciers blocked up the whole inlet and built the foreland beyond the mountain face. The latter advance was less extensive ; the glaciers pushed far down into Disenchantment Bay and filled Nunatak Fiord, nearly all the main portion of Russell Fiord and more than half the southern arm of the latter. The evidence of this advance exists in the form of over-ridden gravels. The recency of the advance was shown by the immaturity of the vegetation which has taken root on the gravels. At the time of the earthquakes, and even till 1905, the recession of the glaciers after the last advance was, with one exception,* still in progress. In that year the surfaces of the glaciers visited were smooth, almost without crevasses, and could be traversed easily for miles.

Ten months later, in 1906, the appearance of some of the smaller glaciers was totally changed. The smooth surface of Variegated Glacier (ten miles in length) was transformed for at least six or seven miles upwards into a wilderness of crevasses, so that it was no longer possible to walk over it ; the front of the glacier, stagnant in 1905, was pushed forward several hundred yards, and its height was raised from one to two hundred feet. Similar changes occurred in Atrevida and Marvine Glaciers (respectively eight and ten miles long). Other glaciers, however, such as Hubbard, Turner, Nunatak, and Hidden Glaciers, had undergone little, if any, material change. These glaciers are among the largest of the district, Hidden Glacier being sixteen or seventeen miles, and Nunatak Glacier twenty miles, in length.

In 1909 the glaciers were again visited. The glaciers that were advancing in 1906 had then become stagnant, their surfaces had so far healed that to cross them was possible, though less easy than in 1905. The turn of the larger glaciers had, however, come. Hidden Glacier had pushed forward two miles in the interval. Its advance had been rapid, but had begun to subside, for its surface was still roughened by the partially healed system of crevasses. Hubbard Glacier was also advancing, though in the following year it became stagnant like the others. Lucia Glacier (seventeen or eighteen miles long) was advancing in 1909, and its surface was so broken that it could not be crossed, though it could be traversed in 1906 and again in 1911. Between the summers of 1909 and 1910 Nunatak Glacier had advanced between seven hundred and one thousand feet. In 1910 the longest glaciers of Yakutat Bay had shown no signs of any change.

Thus, the shortest glaciers were the first to advance, and afterwards, in turn, those of greater length. The phenomena were similar in several respects in all the glaciers. Glaciers, which once moved slowly, advanced with a spasmodic rush : they pushed forwards several hundred yards in ten months or less. At the same time they increased in thickness, in the stagnant portions as well as in those parts that were previously active. Many square miles of their surfaces that were smooth before and practically uncrevassed were transformed rapidly into a wilderness of ice pinnacles and crevasses. Then, after a brief experience of these conditions, the advance of the glaciers came quickly to an end ; a few months were sufficient to restore their stagnant state and to heal the fissured surfaces.

Cause of the Advance.—As in all great earthquakes, innumerable landslips descended from the mountains in the neighbourhood of Yakutat Bay. In many parts, and especially in those adjoining the principal faults, thousands, if not millions, of tons of rock were thrown down ; and great avalanches of snow must have fallen, not once only, but many times, in September, 1899. In the St. Elias, Fairweather, and other ranges, which lie a few miles to the north of Yakutat Bay, the amount of snow- and rain-fall is greater than in any other district of temperate or arctic North America. The snow-line is about two thousand feet high, and above this line practically all the precipitation is in the form of snow, which covers every slope to which it can cling. Much of this snow is shed into the valleys in the form of avalanches ; but, under the severe shakings which the mountains received during the earthquakes, the amount thrown down upon the glacier reservoirs must have far exceeded the normal amount.

If the ordinary oscillations of valley glaciers may be attributed, and with good reason, to variations in snow supply to the glacier reservoirs, the effects of the sudden accessions from innumerable avalanches may be anticipated. They would certainly cause a rapid, but temporary, advance of every glacier, and the advance would be noticeable first in the smaller glaciers and afterwards in those of greater length. The advance would take place in every glacier abruptly. The thrust from the overloaded reservoirs would be transmitted through the lower layers of the glacier, causing the plastic basal ice to flow more rapidly, and thus breaking the more rigid ice at the surface into a mass of pinnacles and crevasses.

* Galiano Glacier, two or three miles in length, had begun to advance before 1905.

XUM

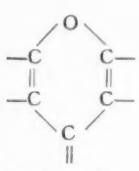
FLUORESCENCE AND CHEMICAL CONSTITUTION.

By S. C. BRADFORD.

FLUORESCENT solutions show at the surface a characteristic colour distinct from that produced by absorption. The fluorescent light is due to vibrations within the medium set up by the impact of the absorbed light-waves. These vibrations are communicated to the ether, and reäppear as light of a different wave-length, and usually of a lower refrangibility than that of the exciting rays. The phenomenon can easily be observed by dissolving a little uranin, the sodium salt of fluoresceïn, in water. The yellow solution has a beautiful green fluorescence. The colouring power of such a solution is very great. Whole rivers may be coloured for a time with a kilogramme of this substance. By this means the underground courses of rivers have been determined.

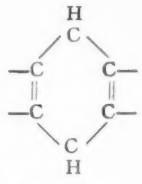
The earliest recorded observation of fluorescence was in 1570, but it was not until 1845 that any scientific explanation was attempted. In that year Sir John Herschel described in *The Philosophical Transactions* a very remarkable phenomenon discovered in a solution of sulphate of quinine. He supposed, however, that the fluorescent light was of the same wave-length as that absorbed. The name "fluorescence" was given by Stokes in his masterly memoir on the subject published in *The Philosophical Transactions* in the year 1852.

Liebmann was the first to attempt to trace a connection between the phenomenon and the chemical structure of the fluorescing molecule. He found, in 1880, that fluorescence is only exhibited by anthracene derivatives when they contain the group M—C(—)—C(—)—M, placed between two benzene nuclei, M being a monovalent radicle The results obtained by Spring in 1897 indicated that fluorescence is characteristic of the benzene ring, since hydrocarbons containing this structure are always at least faintly fluorescent. In the same year R. Meyer undertook a systematic survey of fluorescent compounds, and detected a number of groups, which he termed "fluorophores," whose presence tends to excite fluorescence in the molecule. These are composed of six membered heterocyclic systems, such as :—



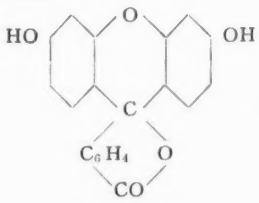
in derivatives of pyrone,

and



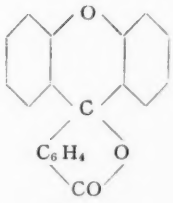
in the anthracene group.

Thus



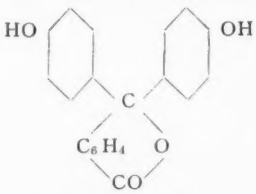
fluoresceïn

and



fluorane

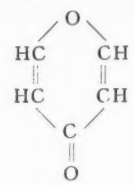
which contain the pyrone fluorophore are fluorescent, while



Phenolphthaleïn

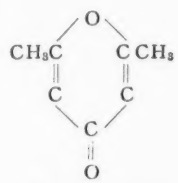
in which the bridge oxygen is absent does not fluoresce.

The mere presence of a fluorophore in the molecule does not seem to be sufficient to excite fluorescence. It appears that benzene nuclei must be attached. Thus



γ-pyrone

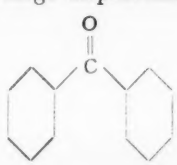
and



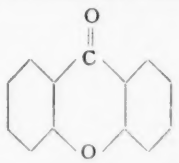
dimethyl-pyrone

are not fluorescent, but when benzene nuclei are substituted for the methyl groups, as in diphenylpyrone, the molecule becomes fluorescent.

The theory of fluorophores as originally proposed does not explain the cause of fluorescence, though it forms a convenient means of classifying fluorescent substances. In 1907 and 1908 Stark made a study of ultra-violet fluorescence by the photographic method, from which it appears that the benzene ring is the seat of the phenomenon, while the fluorophores, by weighting the molecule, serve merely to reduce the rapidity of the vibrations, so as to bring the fluorescent light within the visible region of the spectrum, *e.g.*, the presence of the pyrone ring causes a large displacement, and while in benzophenone



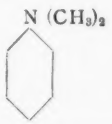
the fluorescent spectrum is entirely contained in the ultra-violet region, that of xanthone



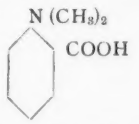
and its derivatives is in the visible portion of the spectrum. This result has been obtained by Kauffmann from another point of view.

The vapours of many substances become luminous when exposed to the action of the Tesla discharge, particularly under low pressures. The relations between constitution, luminescence, and fluorescence have been very fully investigated by Kauffmann since 1900. From his researches it appears that luminescent compounds possess in common certain groups which evidently provoke the luminescence. These he called "luminophores." The benzene nucleus appears to be the seat of the luminescence, which does not manifest itself, however, until "auxochromes" are introduced. These are unsaturated salt-forming groups, associated with the production of colour in coloured substances. Kauffmann further showed that in aromatic substances the property of luminescence runs parallel with (*a*) increased reäctivity, (*b*) a tendency to yield *p* quinones on oxidation, and (*c*) optical and magneto-optical anomaly. From which it appears that this property is likewise due to the disturbing action of the unsaturated substituents on the residual affinities of the benzene nucleus, which approaches the *p* quinonoid state represented by the Dewar formula:

The presence of an auxochrome is not alone sufficient to excite fluorescence; another group, called the "fluorogen," must be added. Thus in

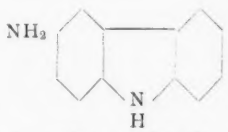


dimethylaniline, the auxochrome $-N(CH_3)_2$ causes luminescence, but the fluorescence only appears on the introduction of a fluorogen, such as $-CO_2H$ in



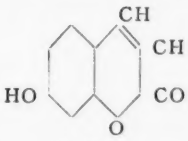
dimethylanthranilic acid

In



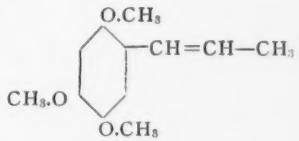
3 - amino - carbazole

the benzene ring acts as the fluorogen, while the $-NH_2$ and $=NH$ groups are the auxochromes. Other groups capable of acting as fluorogens are: The acrylic acid group $-CH=CH.CO_2-$, as in



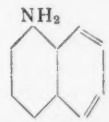
umbelliferone

; the ethylene linkage $-CH=CH-$, as in



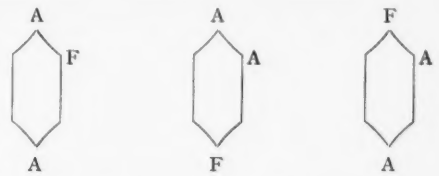
asarone

and conjugated ethylene linkages, as in

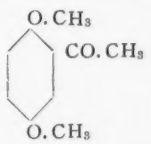


α-naphthylamine.

Fluorescence is further determined by the relative positions of the fluorogens and auxochromes. If there are two auxochromes and one fluorogen present, fluorescence occurs only if their positions are such as to induce the *p* quinoid condition, *i.e.*, if they are unsymmetrical. Thus only substances of the following types are fluorescent:—



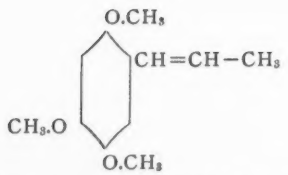
where A is an auxochrome and F a fluorogen, as, for example, in 2.5-dimethoxyacetophenone,



where the methoxy groups are the auxochromes and the $-CO.CH_3$ the fluorogen.

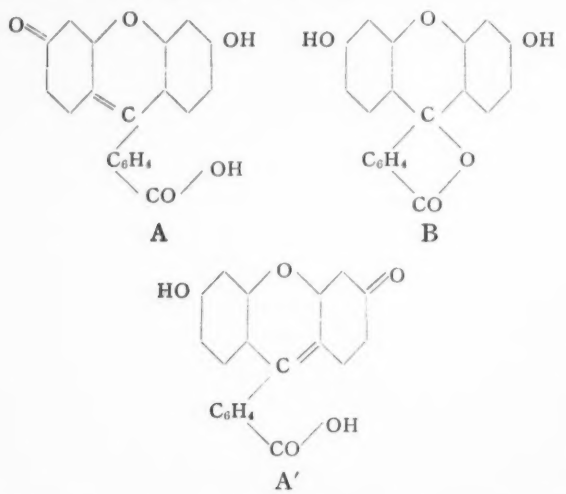
If three auxochromes and one fluorogen are present, fluorescence does not occur where the fluorogen and two of the auxochromes are adjacent, so that it is only to be expected with the constitutions:—

as in asarone,

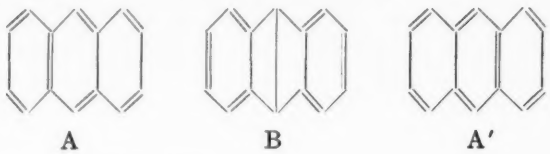


Wiedemann suggested in 1889 that the molecule of a fluorescent substance exists in two forms, one more stable than the other. The stable form, on absorbing the energy of the light-vibrations, is transformed into the less stable variety, which passes back to the former with emission of the absorbed energy as fluorescent light. These forms may be due to the shifting of an atom within the molecule.

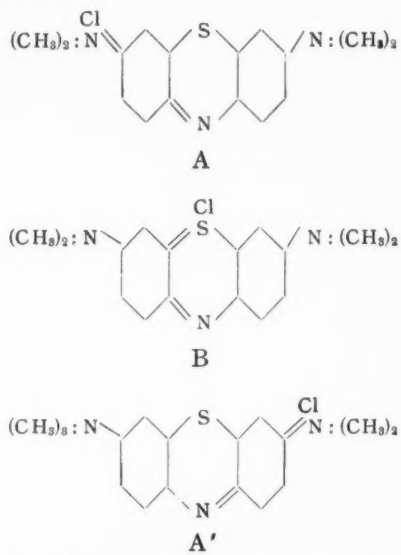
The connection between tautomeric change and fluorescence was, however, first clearly explained by Hewitt in 1900, who showed that there is a certain kind of tautomeric variation which must be especially adapted to fluorescence: *e.g.*, fluoresceïn may exist in the quinonoid form A, or the double hydroxyl form B :—



and, under the influence of light, a rapid change, analogous to the swing of a pendulum, may take place from A to B, and thence to A′, which is identical with A. This is an example of " double symmetric tautomerism," since it can only occur in those substances in which the tautomeric change may involve either of two symmetrically arranged identical groups, *e.g.*, the OH groups above. The alternations thus involved would take place rapidly, and require little external energy for their maintenance. In confirmation of this we find that all substances which show this tautomerism are strongly fluorescent, as anthracene,



and methylene-blue,



Drude showed in 1904 that the infra-red portion of the spectrum is influenced by the vibrations of the atom or groups of positive electrons, while the visible and ultra-violet spectrum is due to the dispersional or valency (negative) electrons; and as no infra-red fluorescence has been detected he ascribes the fluorescent vibrations to the valency electrons. We see, therefore, that the tautomeric changes described above may be produced by the change in position of a valency electron.

This theory of fluorescence, which requires the presence of mobile negative electrons or valencies, agrees with the chemical evidence which proves the origin of the vibrations to be in the benzene nucleus, the residual affinities of which are shown to be in a state of continual oscillation.

THE OCTOBER ORIONIDS.

By W. F. DENNING, F.R.A.S.

THE earliest Orionid seen in 1915 was on October 4th, 11h. 43m., by Mrs. F. Wilson from Portscatho, Cornwall. It had a path from 96½°+25° to 101°+30½°, and left a bright streak. Two others were seen on October 5th, 10h. 34m. and 11h. 42m., by her; and on October 13th I observed a bright meteor of the same shower.

On October 19th, between 16h. 10m. and 17h. 3m., Mrs. Wilson watched the eastern sky, and saw the shower

under a very definite and fairly rich aspect. From eight well-observed paths she obtained the radiant at 91°+15°. This agrees with the best previous determinations. For

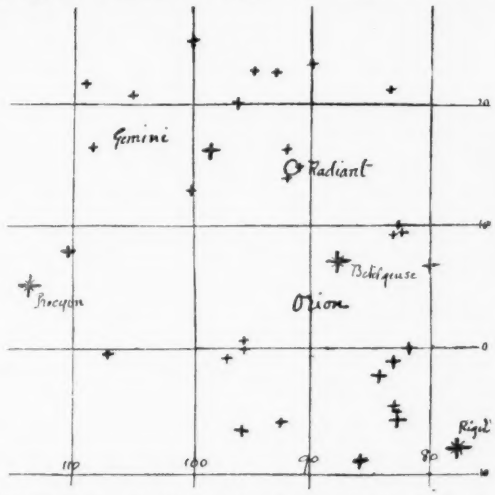


FIGURE 18. Position of the Radiant of the Orionids.

several years, in about 1900–03, I saw a shower at 100°+13°, which seemed to have displaced the Orionids as the richest display of the epoch; but in the present year the true Orionids quite maintained their old-time predominance. The weather, however, was very unfavourable, and prevented observations on many nights following the 19th. On 28th, 29th, and succeeding dates no Orionids were recognised, and the shower certainly appeared to have become extinct. But the sphere of vision of one observer is limited, and the results of a single year are not representative of many returns.

I have occasionally seen unmistakable Orionids at the end of October and early in November. In any case a few streaking meteors displayed all the characteristics of the members of this system, and their flights were directed precisely from the radiating point at Nu Orionis.

Between October 14th and 25th the shower is fairly active, and it may be traced with facility whenever the weather is clear and there is no strong moonlight. There are annual variations in the number of meteors visible; but this system apparently forms a complete ring, and is as regularly recurrent as the August Perseids or December Geminids.

The shower has no cometary derivation, so far as the facts are at present known. In other words, no comet has been observed whose orbit corresponds with that of the Orionids. But this stream of meteors has, in contradiction to the Perseids, a radiant point which remains stationary in the heavens during the whole period that its activity is visibly maintained. I first saw the display in 1873, and since that year I have never detected any displacement in the place of radiation, and the position is one which is very sharply defined.

The rich companion or contemporary shower, at about 100°+13°, is often liable to be confused with the Orionids unless the observations are very exact. The former is really a display of Geminids, and furnishes a very well-pronounced shower both in September and October.

It is important that the Orionids should be carefully observed in future years, so that the stationary radiant may be properly substantiated by adequate materials. The writer has already investigated the point, and is satisfied with the correctness of his conclusions. It now remains for others to test them; and this test must be applied on the basis of accurate observations and reliable reductions.

REVIEWS.

PHILOSOPHY.

Know Thyself.—By BERNARDINO VARISCO. Translated by GUGLIELMO SALVADORI, Ph.D. 327 pages. 8½-in.×5½-in.

(George Allen & Unwin. Price 10/6 net.)

This is a volume in the excellent "Library of Philosophy," edited by J. H. Muirhead, LL.D., and forms a valuable addition to a series which contains also Professor Varisco's "The Great Problems" (translated by R. C. Lodge, M.A., ix+370 pages. 8½-in.×5½-in. Price 10/6 net). It would be odious to institute comparisons between living philosophers, but one can say, without fear of creating odium or inviting criticism, that Professor Varisco is one of the modern world's greatest thinkers, and it is well for us, who speak the English tongue, to have translations of his works in our own language. His books are by no means easy reading; yet they will certainly repay one for the effort needed, and the author has the valuable gift of dealing with the commonest phenomena of everyday life in such a manner that we see them in a new and significant light.

"The Great Problems" should be read first. Professor Varisco's definition of "body," there given as "a group of sense-perceivables bound together by a law," reminds one of Professor Ostwald's—no doubt well known to readers of "KNOWLEDGE"—with which it is practically identical. Whilst, however, there is much in the author's words which might justify us in labelling him an idealist (though such labelling is never very satisfactory, and can never take the place of adequate criticism), he dissociates himself from idealism, or from one aspect of it, on the ground that idealists have wrongly identified reality and cognition ("Know Thyself," page xxi). "A fact," he writes in "The Great Problems," "which, while remaining one and the same, realises itself in two or more subjects must be able to realise itself also apart from any subject whatever"—a questionable statement which ignores the pluralistic possibility, though that is not its only alternative.

But since the attempt to give any account of his system in the brief confines of a review would be foolishness, I must, in fairness, refrain from criticism. This system is not a completed one, Professor Varisco says, and that surely means that his thought is living. What greater thing could one say of it? "Man will never arrive at knowing everything; but, on the other hand, there is nothing of which we can assert that man will never reach the knowledge of it," he writes; or, as I have put it elsewhere, man's progress towards a knowledge of absolute truth is an asymptotic one. To have enabled us clearly to envisage in their various aspects and bearings the great problems, to have convinced us of the need that we should know ourselves, and to have shown us the enormous implicits of self-knowledge, that to know ourselves we must know God—that is something, indeed, and something for which we ought to be grateful.

H. S. REDGROVE.

PHYSICS.

A Treatise on the Theory of Alternating Currents.—By ALEXANDER RUSSELL, M.A., D.Sc., M.I.E.E. Volume I. Second edition. 534 pages with 157 figures. 8½-in.×5½-in.

(Cambridge University Press. Price 15/- net.)

This being the second edition of a work published ten years ago, it contains several new chapters dealing with subjects such as high-frequency currents, which have come

into greater prominence since the first edition appeared. In this volume the mathematics of the important theorems underlying the subject are given, the theory of alternators, motors, transformers, and so on, being reserved for treatment in the second volume.

The subject-matter is not closely confined to alternating currents, but includes much of the substance of mathematical electricity in general. The references to original sources (many of them to papers by the author), which are placed at the ends of the chapters, are a valuable feature of the work. The treatment is clear and thorough. The student must bring to the task of studying this book a good mathematical training, and he should already have a sound knowledge of electricity and magnetism.

J. H. V.

A Treatise on Light.—By R. A. HOUSTOUN, M.A., PH.D., D.Sc. 473 pages. 328 diagrams. 8½-in. × 5½-in.

(Longmans, Green & Co. Price 7/6 net.)

This book is intended to meet the requirements of students who have been through a first year's course of physics, and are desirous of proceeding still further with the study of light. The first part of the volume deals with geometric optics in which the properties of mirrors, lenses, and various optical instruments receive very able treatment. In the second part, which is devoted to physical optics, the phenomena of interference, diffraction, and polarisation are considered. In Part III the subject of spectroscopy, photometry, the eye, and colour-vision, lamps and illumination, are dealt with in a clear and interesting manner. Part IV is devoted to the mathematical theory of the nature of light, its reflection, refraction, dispersion, and radiation. The book contains an unusually large amount of valuable information, including the results of recent investigations; while at the end of each chapter there are a number of illustrative experiments and examples. It is evident that the author has taken special pains to give a very comprehensive account of the phenomena and laws concerning the study of optics, which any student with a good knowledge of elementary mathematics should be able readily to follow.

E. S.

Numerical Examples in Physics.—By H. SYDNEY JONES, M.A. 332 pages. 9 illustrations. 7-in. × 4¾-in.

(G. Bell & Sons, Ltd. Price 3/6.)

This book contains a large number of well-chosen numerical examples on heat, light, magnetism, and electricity. An appendix gives a list of physical and other constants, and the answers to the examples are given at the end. Students preparing themselves for examinations, in which due weight is not given to practical tests and laboratory records, will probably find that working through such a book as this pays from the standpoint of marks. On the other hand, it is not at all unlikely that students more happily circumstanced might spend the time more profitably.

J. H. V.

ZOÖLOGY.

British Ants.—By H. ST. J. K. DONISTHORPE, F.Z.S. 379 pages. 18 plates. 92 figures. 8¾-in. × 5½-in.

(Plymouth: William Brendon & Son. Price 21/-.)

We could have wished that the results of Mr. Donisthorpe's twenty years' work on British Ants had made their appearance at a more auspicious time; but there can be no doubt that when the present troublous times are past many naturalists will turn to his pages to read the interesting details with which they are crowded; while others will be induced to take up the study of British Ants, and by their work in the future repay Mr. Donisthorpe for what he has done; for there can be no greater reward to the pioneer in neglected branches of British natural history than to find that others through his efforts are led to carry them on.

Mr. Donisthorpe's monograph begins with a succinct account of external and internal structure, illustrated by diagrams on which the parts are labelled in full, the advantage of which the present reviewer has never ceased to emphasise. Of special interest are the paragraphs on the life-history and the way in which new colonies are founded. The large number of forms which ants assume will come as a surprise to many, who know that there are winged males and females and wingless workers, but are hardly prepared for twenty-nine phases.

Mr. Donisthorpe says that queen ants are not reared in captivity, a single exception being recorded by Lord Avebury; but a footnote added by Mr. Donisthorpe after the book was printed, states that a colony which he had in his possession for longer than five years has just produced a number of winged females. The general reader will be interested in the notes on psychology, and in what Mr. Donisthorpe has to say of the way in which ants know each other, communicate with each other, and find their way. The nature student will find the details on collecting and keeping observation nests of particular usefulness. Another feature of the book is the lists of the many insects, mites, spiders, and crustacea which find a home with the various species of ants.

The thirty-three species of British ants are dealt with in detail, and excellent plates are given showing males, females, and workers. We congratulate Mr. Donisthorpe on his book, and hope that its purpose will be fully attained.

W. M. W.

NOTICES.

THE SCIENTIST'S REFERENCE BOOK AND DIARY for 1916 has now been published by Messrs. James Woolley, of Manchester. It includes, besides general information, explanations of astronomical and other terms, notes on meteorology and various sciences, tables and equivalents, factors and synonyms; while several pages are devoted to first aid in poisoning cases. The diary is most useful and convenient, and we commend it to our readers. The price of it is 2/-.

BOTANICAL SURVEY OF SOME FIELDS NEAR LEICESTER.—Mr. A. R. Horwood, in an appendix which he contributes to a paper by Miss C. E. C. Measham, says that the publication represents the first-fruits of his endeavour to get a number of observers to make careful and systematic examinations of a limited area field by field, taking the Ordnance maps as a basis, and recording their observations with reference to the numbered tracts upon their maps. He also points out that the observations printed are only a summary of what has been carried out, but that they serve as an excellent example as to how such work should be done. The Appendix gives notes on the soil, for on the character of this the distribution of the plants is, in the main, regulated. A feature which requires especial study is the effect and the amount of the effect of cultivation. In Leicestershire tree-felling in the first instance and corn-growing in Norman or Pre-Norman times, the last indicated by ridge and furrow, have in Leicestershire left considerable marks.